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The Journal of Thoracic Surgery

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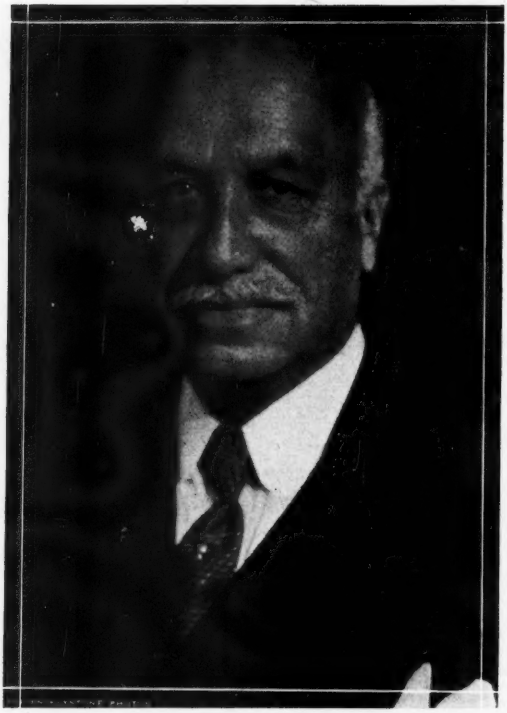

DR. WILLY MEYER

1858-1932

Founder of the American Association for Thoracic Surgery

The Journal of Thoracic Surgery

VOL. I JUNE, 1932 No. 5

IN MEMORIAM*

Dr. Willy Meyer
1858-1932

An Appreciation

THE American Association for Thoracic Surgery now holding its 15th annual session has assembled to mourn the loss of its illustrious founder, in the death of Dr. Willy Meyer, of New York, who passed away at the New York Academy of Medicine on February 24, 1932.

The news of his sudden death in the dramatic circumstances in which it occurred was a great shock to the medical profession and particularly to the members of this Association who knew him best by his unfailing attendance at the meetings and his deep interest in the welfare of the organization. To his more intimate friends, the manner of his death was not surprising, since it was known that Dr. Meyer was suffering from a myocardial lesion, which at any time, under physical or emotional strain, might end his great career. And so it happened that while attending a meeting of the New York Surgical Society, he participated in a discussion on "Cancer of the Breast," a subject of the deepest interest to him and on which he has permanently left the imprint of his name. In the course of the discussion some of the remarks had been of a discouraging and pessimistic character. This made him get up and in his always earnest and appealing way, he spoke his convictions and his hopes for the victims of cancer. He pointed his remarks by citing the cure of a patient on whom, in 1894, he had performed the first operation by the radical procedure that bears his name, and who remained well during the thirty-one remaining years of her life.

This was Dr. Meyer's last public utterance and it was characteristic of the man. He could not miss an opportunity to convey a message of hopefulness for the victims of cancer; of encouragement for the present and still greater hope for the future. Never a pessimist, always an

*Read at the President's Banquet at the Fifteenth Annual Meeting of the American Association for Thoracic Surgery at Ann Arbor, Michigan, April 19, 1932.

optimist and a confident believer in the final triumph of science and surgery in the eradication of cancer.

Dr. Meyer was always an optimist and never a pessimist in dealing not only with cancer but with everything else. He seemed to be inspired by a spirit of hopefulness which never deserted him. He was never dismayed or discouraged in the presence of what seemed to others, insurmountable obstacles. He was never checked by surgical adversity as long as he was convinced that there was a road open to success. In solving his many problems, he was persistent, patient, and unremitting in seeking for new openings, new paths to widen the prospect of the present and to add joy to the vision of the future. His courage, his cheerful philosophy and his tenacious perseverance in subduing even the most rebellious problems, were perhaps never better illustrated than in his lifelong fight with cancer, in his increasing efforts to better the conditions of thoracic surgery in its rugged and unpromising beginnings, and in his pioneer efforts to improve the miserable lot of the old prostatics of twenty years ago. In fact, this tenacity of purpose and smiling attitude under difficulties, are recognizable as a trait throughout the long history of his professional activities in which he has left the imprint of his footsteps as an explorer and pioneer.

But perhaps no other circumstances in his life better illustrate his imperturbable equanimity and cheerfulness of spirit, than the way in which he faced the closing episode of his life. For he knew, and his intimate friends knew with anxious apprehension, months before the fatal hour that was to end his earthly career, that he was suffering from an incurable heart lesion, which menaced him with sudden extinction at any moment. Though aware of his peril, he never yielded to gloomy prognostications or preoccupations, but continued serene and undeterred to participate, with unabated interest and unconcern about his fate, in all the professional activities and associations which constituted the pivotal center around which his energies, his best thoughts, and his affections had revolved during the nearly half century of his American life.

There is something inspiring and beautiful in the Socratic calm, if not actual indifference, with which Dr. Meyer envisaged his approaching end. Despite his long and arduous career of service and incessant travail, he never seemed to feel or act as though his task had ended, and that he was entitled to repose. Even under these rather unnerving circumstances, his enthusiasm went hand in hand with his optimism. Though he had retired from actual practice in the last few years before his death, his interest in all matters that concerned the progress of surgery never lost its keenness. He hailed every advance, every step forward in medicine with the same enthusiasm with which he worked clinically, surgically and experimentally, in earlier years to perfect the technics of thoracic surgery. Those of us who are his contemporaries remember the vast energy, thought, and expense that he put into the

construction of his modification of the Sauerbruch negative chamber, to obviate the risks of acute surgical pneumothorax. It was only four months before his death that this memorialist spent an hour with him and his son, Dr. Herbert Meyer, at the Lennox Hospital, going over the details of the radio-thermic apparatus devised by the General Electric Company, as a means of inducing an artificial or "synthetic" fever, and in discussing its therapeutic applications and possibilities. His interest and enthusiasm were indeed refreshing and inspiring. There was nothing to suggest in his manner or thought that he did not expect to see the end of the experiment. He certainly did not act like a man on whom a medical tribunal had passed a sentence of death. While we were together in New York, he entertained delightfully at his hospitable board and kept his guests charmed by the lively stories and experiences of his early student days at Bonn and Erlangen. He rarely missed the surgical meetings and reunions where he was always expected to say something that added to the value of the discussions and which reflected his vast knowledge and experience.

In all this he never made it apparent that he was aware that the sword of Damocles was hanging over his head by a thin thread, and yet he knew that he must not be rash in too boldly challenging the fate that was awaiting him, and he was prudent, not because he was afraid, but because he wished to live to be useful and to be useful as long as he lived.

In the death of Dr. Meyer, The American Association for Thoracic Surgery mourns not only the loss of its founder, but a father who watched over its birth, growth and development with all the affection and tender solicitude that a parent would give his child.

The success of the Association, its steadily growing membership and increasing importance, fully confirmed his fondest anticipation.

The annual transactions, well filled with nutritious articles and growing stouter in the fourteen years of their publication, found further expansion in the JOURNAL OF THORACIC SURGERY, thus giving the Association a new and unique status in the great forum of the surgical specialties.

The contemplation of the progress accomplished and the bountiful harvest that has been reaped from his sowings, gave Dr. Meyer great joy and were among the most satisfying rewards of his professional life.

Dr. Meyer was a great surgeon in many ways: In the number and quality of his contributions to the science and art of surgery and he was great in his consecration to the profession which he loved with a singleness of purpose and a purity of motive that made his individuality stand conspicuously in a world that is largely governed by a more material and palpable idealism.

As a surgeon he was brave and bold, almost to temerity, always tempered, however, by reason and by a high sense of duty to the patients who entrusted themselves to his care. He always meditated long and

seriously before undertaking an operation of gravity; but once come to a decision he was capable of the most formidable enterprises, but only when he felt that these might be rewarded by the saving of a human life.

His boldness, his courage and skill were perhaps exhibited at their best when he was treading on new, dangerous, and uncultivated ground. His early and pioneer operations on the esophagus, the mediastinum, the lungs and the diaphragm fully attest these characteristic traits.

His honesty in reporting his failures as well as his successes was thoroughly in keeping with the absolute integrity of his character. He never magnified his successes nor minimized his failures.

Simple, modest, unpretentious and approachable, he was ever considerate of the feelings and rights of others. He was respected by all who knew him. His discussions at medical meetings were always characterized by clarity, gentleness, moderation. He always praised whenever he found reason for commendation, and his criticisms, whenever called for, left no bitterness or sting behind them.

Dr. Meyer's sincerity, his loyalty, his humanity, deep understanding and warm sympathy made his friendship a great privilege and priceless possession.

His home life was ideal. He, his wife, and their two surviving children were united "as the leaves of a four leaved clover"—to quote one of his own similes. His son, Dr. Herbert Willy Meyer, describes the perfect harmony of the domestic circle by saying "we were divinely happy together."

The death of his wife in 1928 was a terrible blow which bent him low with grief, but the love of his children and grandchildren came to the rescue, and he rose from his bed of anguish comforted by their caressing devotion.

A paragraph received from his disconsolate son shortly after the great catastrophe will perhaps best serve to illustrate the love and devotion that Dr. Meyer inspired. He writes: "In the tribute paid to father at the funeral, in the beautiful church of St. Thomas, Dr. Brooks, the rector and his friend, closed his touching eulogy with the words, 'So kind, so sweet, so gentle.' And these words ring in my ears constantly and are like a balm in the wide wound that father's death has torn in my heart. We were like brothers together. There was no case that he had that he did not discuss with me and there was no case that I had, that I did not go to him for advice and counsel, which he would always give me to the full. The years that we spent together since I finished my internship in 1920, were heavenly, wonderfully happy years. They are a beautiful memory."

In the passing of Dr. Meyer the profession has lost not only a great surgeon, but a great soul. He has left an example of untiring industry and a record unsurpassed by his devotion to the highest ideals of the

surgical life. To his family and his people he has left the legacy of a name that is more precious than all earthly treasures, for it is synonymous with the words *probity, loyalty,* and *humanity.*

No man, who has done so much to promote the welfare of his fellows and has carried his mission so high, so well, so whole heartedly and so cheerfully, can depart from this world without leaving a hopeful impulse behind him to better the traditions of mankind.

RUDOLPH MATAS.

Dr. Willy Meyer: A Biographic Sketch

DR. MEYER was born on July 24, 1858, at Minden, Westphalia, Germany. He was the third of six children born of the union of Abraham and Bertha (Simon) Meyer. He was the youngest of three brothers; the oldest, Julius, became an engineer and attained distinction in his profession as a builder of railroad bridges in the far Northwest, during the early development of this country. In later years he was instrumental in the construction of the negative and positive pressure chamber which Dr. Meyer had installed at the Lennox Hospital in 1909 as an improvement on Sauerbruch's differential chamber for intrathoracic work. He was also a great helper to Dr. Meyer as a literary assistant in his bibliographic researches on cancer. They were the only two in the family to adopt professional vocations.

Dr. Meyer's childhood and youth were passed in Minden, where he was reared in the midst of the happiest family surroundings. His father, a prosperous grain merchant, did everything to give his children the best education that the grammar schools and Gymnasium of Minden afforded. In Minden, Dr. Meyer had been well grounded in the classics, and when he matriculated at the Medical School in Bonn, he was unusually well prepared in Latin and Greek and had a good working knowledge of English and French in addition to a mastery of his native vernacular. He was fond of telling how he and the young assistants working in the clinic in Bonn would mystify the patients by speaking only in Latin among themselves so that the patients might not understand what was said about them. His son, Dr. Herbert Meyer, has a copy of a letter that he wrote to Dr. Abraham Jacobi in Latin when he was still a mere boy. At Bonn, he joined the "Burschenschaft Alemania," a students' fraternity in which he kept up a lively interest during his life. In keeping with the German student traditions, he fought two duels which left some trace behind them. From early youth he displayed a great fondness for the outdoor life and the study of Nature, and found delight in collecting the wild flowers of the Rhineland; and flowers remained one of his hobbies to the end. Of an esthetic and deeply musical temperament, he soon became an accomplished pianist. He displayed so much talent and mastery of the technic, that his mother had decided he was destined for a musical career, when he, yielding to other influences and to his own more mature inclinations, finally adopted medicine as his profession.

His first interest in medicine came through Dr. Abraham Jacobi, an old friend of the family who had attained fame as a great scholar and pediatrician long before migrating to America. It happened that on one of his periodic visits to Germany, Dr. Jacobi needed a secretary who could follow him on one of his lecture tours through the German clinics. As he knew that Willy Meyer was adept in German shorthand, he obtained the father's consent to his son's accompanying him as his amanuensis. It was this close contact with Dr. Jacobi that laid the

foundation for an attachment and enduring friendship which only ended with Dr. Jacobi's death in 1919. After six months of obligatory service with his regiment at Erlangen and an additional six months of study in that faculty, he returned to Bonn and was graduated with the degree of Doctor of Medicine in 1880. He then finished the second half of his military service as a volunteer surgeon and joined the medical faculty of the University of Bonn as assistant to the surgical clinic. During this time he became engaged to Miss Lilly Ottilie Maass, a playmate of his childhood, whose parents had moved to New York, but who visited Minden with them every summer. They were engaged four years, during which Dr. Meyer remained in Germany and Miss Maass in New York. At Bonn, his first chief was Professor Wilhelm Busch who had attained great distinction as surgeon general of the German army during the Franco-Prussian War and who died from acute gangrenous appendicitis (1881), three months after Dr. Meyer became his assistant. Professor Madelung, also a familiar name in surgical literature, came next and remained in charge of the clinic at Bonn for nine months, when he was called to the Chair of Surgery at Strassburg. Then Friederich Trendelenburg followed, and the coming of this great surgeon marked a notable period in young Meyer's life. For three years Dr. Meyer served under Trendelenburg as his first assistant, and their relations soon warmed into a close friendship which continued during their lives. It was during Dr. Meyer's term of service that Trendelenburg conceived and demonstrated the advantages of the high pelvic position—the Trendelenburg position—which is now universally recognized as one of the most important factors in the modern development of abdominal and, especially, pelvic surgery. Dr. Meyer had so completely won the confidence and regard of his chief, that the latter authorized him to write the first account of this great discovery and to publish it in Langenbeck's Archives for 1884. Emigrating to America in the fall of 1884, Dr. Meyer settled in New York City and engaged in the general practice of medicine. He was so successful that in 1885, less than a year after his arrival, he felt secure enough to marry and establish a home with the faithful young woman who had patiently waited his coming for nearly five years, to become his bride.

In 1886, he had prospered beyond his expectations and felt that he could yield to his early inclinations for surgery by specializing in this branch. He had come to America practically a poor man, with no capital or influence to back him, except his own professional worth, his indomitable will, and his boundless enthusiasm for work. He always recalled his early days in New York with profound and everlasting gratitude; gratitude, he said, for the kind reception accorded him, for the opportunities given him for advancement, and for the immeasurable happiness he had found in his American home.

Shortly after his arrival in 1884, he was admitted to the German dispensary in New York, as assistant in the surgical department. In 1886, he was elected Professor of Clinical Surgery at the Woman's Medical College, teaching in this capacity from 1886 to 1893. In 1886 he was also appointed attending surgeon to the New York Skin and Cancer Hospital and the Lennox Hill Hospital, then known as the German Hospital, and in 1887 to the Postgraduate Hospital. He held all these positions until 1923 when he reached the age limit and became consulting surgeon to these institutions and to the New York Infirmary for Women and Children, Stuyvesant Square Hospital, Bronx Hospital, the Hospital for Joint Diseases, the Montefiore and Glens Falls Hospital.

Though, in the beginning of his career in New York, he was compelled to face the practical bread and butter problems of life, Dr. Meyer's inquiring and restless mind was never diverted from his passionate interest in the higher cultural and scientific aspects of his profession. He had scarcely settled in New York when he made his presence known by a series of innovations and contributions to the current literature,

that at once marked him as an investigator and as a new and stimulating force in the profession. In 1884, he brought with him the then new knowledge of the Trendelenburg position and demonstrated its immense value on the special table that Trendelenburg had devised for this purpose. In 1887, he introduced cystoscopy with a modification of the Nitze cystoscope. In 1896, he was the first to perform successfully ureteral catheterization with a modified Caspar instrument. In 1897, he introduced the Bottini operation for obstructive hypertrophy of the prostate, and resorted to this procedure with notable success in the treatment of this condition. About the same time, he imported and was the first to introduce the new methods of performing gastrostomy for stricture of the esophagus, which Witzel, Marwadel and Kader had recently devised in Germany—to prevent leakage and regurgitation of gastric contents through the fistula. In 1905, the Index Catalogue of the Surgeon General's Library recorded a list of 27 references to his publications, some of them of a monographic character, covering a large range of subjects. This list was only a forerunner of the steady stream of literature which flowed from his busy pen as this recorded his many and varied surgical activities during the thirty-one years that followed and that he kept up until the very end of his career. The published proceedings of the New York and the American Surgical Societies show few meetings in which he did not appear as a contributor to the discussions with papers and observations; always with some new message, some fact of importance that contributed to the value of the meetings and that displayed his inexhaustible energy, his boundless enterprise and his quick apprehension and utilization of every new development in surgery.

We need go no further than the general index of the Annals of Surgery from 1884-1924 to find that this journal contains 357 references to the articles and discussions and other papers that were published in this journal alone, during the forty years included in this period.

His early publications deal largely with sterilization and anesthesia—local and general—and hemostasis, which are interwoven with the aseptic period of the renaissance of surgery, following in the wake of the Listerian revolution of the eighties and nineties. Besides, the above list does not include his book on Bier's Hyperemia which he published with Schmieden in 1909, or the many articles that appeared in other journals, which, when put together, would constitute a fairly complete record of the progress of surgery and of all the notable events that transpired during the last half century.

In 1895, after the death of his eldest daughter from acute gangrenous appendicitis, he concentrated his attention on the appendix and published a series of papers in which he took an advanced stand, regarding appendicitis as a surgical disease *ab initio*, stressing the importance of early operation and, if possible, from the moment that the diagnosis of acute appendicitis was established. In this, as in other questions, he did the work of a pioneer. In 1889, Dr. Charles McBurney had performed the first successful appendectomy for acute gangrenous appendicitis, and his memorable paper had been a signal for a more aggressive policy in dealing with the appendix. But the profession was still in doubt. The majority were in favor of delay, of purely medical treatment, and operations were performed late after suppuration and peritonitis had set in. His early papers entitled "When Shall We Operate for Appendicitis?" (1896); "The Hockey Stick Incision for Appendicitis" (1900); "Rare Complications After Operation for Appendicitis" (1901); "The Additional Posterior Incision in Certain Cases of Operations for the Inflamed Retrocecal Appendix" (1924), and other titles recall his active participation in the revolution of the Nineties that brought the appendix and its malign pathology within the domain of surgery.

The study of cancer fascinated him and he gave early proof of his deep interest

in its problems by the publication in 1891 of a clinical and experimental study of the "Effects of the Anilin Dyes, Especially Soluble Pyoctanin, in the Treatment of Inoperable Malignant Growths," a mode of treatment which recent bacteriologic research had given much hope of therapeutic and curative value, but which in the end proved disappointing. In 1894, his long meditations on the seemingly hopeless inefficiency of surgery in the treatment of cancer of the breast, as practiced up to that time, found expression in a very original paper entitled "An Improved Method of Radical Operation for Cancer of the Breast" in which he laid down the principles of a wide block excision of the breast to include the complete extirpation of the axillary contents and of both pectoral muscles, followed by skin grafting to cover the large defect. These principles, which at the time were regarded as too drastic and radical by many of his contemporaries, are those which, with certain modifications in technic, govern the operation for cancer of the breast as it is performed today.

It is a singular coincidence that Dr. Halsted's monumental contribution on the same subject appeared in the *Annals of Surgery* for November, 1894, only ten days before Dr. Meyer had read his paper before the section of Surgery of the New York Academy of Medicine (Nov. 12, 1894) in which he described with perfect detail an operation based on identical principles and virtually the same technic. Meyer, in an addendum to his paper makes it clear that he had worked long and independently on the plan and method of his operation, and was not aware that any one had preceded him in the same direction; and much less that Halsted had been at work with his operation since 1888 and performed it on fifty patients with the unprecedented record of 94 per cent three-year cures without recurrence, obtained by his operation. Meyer had not had an opportunity to apply the new principles and technic of his operation until two months before reading his paper, and was therefore not prepared to show the vast superiority of the new over the old operation in the end-results, as Halsted had done so brilliantly and conclusively. It was twenty years later that Meyer (*Annals of Surgery* **12**: 177, 1920) confirmed the thoroughness of his work by reporting fourteen patients on whom he had operated (by his method), who were living and free from recurrence from six to twenty-five years, five of these from twelve to twenty-five years, after the operation. It is touching to recall that his last words in the closing episode of his life (Feb. 24, 1932) were to emphasize his faith in the surgical cure of cancer by quoting the experience of one of these patients who had survived thirty-one years after the operation without a sign of recurrence, dying finally of other causes.

It was characteristic of the man that far from expressing disappointment and chagrin that Dr. Halsted had anticipated him in the planning and performing of an operation to which he had devoted so much thought and had regarded as original with him,—he was elated by the magnificent demonstration that Halsted gave of the soundness of the principles which Meyer advocated and which assured a better future for the patients operated by the method that he and Halsted had independently devised.

In the thirty-seven years that intervened between 1894 and 1931, Dr. Meyer became more than ever interested in the consuming problem of cancer and contributed many articles to the various surgical and special societies devoted to cancer research. These culminated in 1931 in the publication of his book "Cancer: Its Origin and Development; the Theory of Inoperable Cancer in the Light of a Systemic Conception of Malignancy." No one can read this remarkable book without being impressed with the enormous erudition and scientific resourcefulness of the author, and wondering how he, a busy practitioner of surgery, had found time to assimilate and digest the immense mass of literature that he, with the aid of his brother, Julius, had collected on every possible phase of the subject, and condensed it in the narrow

space between the covers of this 400-page volume. Of special interest is the chapter on the meaning of "Predisposition" and his answer to the question "What is it that, in the multitude of individuals exposed to the same injuries differentiates the few responding with cancer, from those remaining unaffected or apparently immune?" The answer to this question is the basis of a thesis which he develops in the light of a systemic conception of malignancy. This involves changes in the whole chemistry of the organism which disposes the individual to cancer in the presence of local irritation and other factors which alone would prove banal and insignificant. He views the problem somatically, by the light of a humoral pathology thoroughly transformed and modernized by chemico-biologic research.

Whether further research will attach as much importance to alkalosis as a distinctive feature of cancer predisposition, or even accept his conclusions in their entirety, may be questionable, but what is unquestionable is that Dr. Meyer's book is a treasury of the most important facts related to cancer, gathered from every quarter of the globe and from the most varied and freshest fountain sources of knowledge. It is not a mere encyclopedia of interesting and instructive facts, but a logical thesis built upon a huge pyramid of the most pertinent, illuminating and well-ordered data.

If Dr. Meyer had left no other legacy than this book, it would suffice to assign him a place in the front ranks of the thinkers and builders of his profession and exhibit him as a rare type of surgeon, who though immersed in the distracting routine of a busy surgical life was able to combine with a perfect mastery of its purely technical accomplishments, the qualities of the accomplished scholar, scientist and philosopher.

The outstanding feature of Dr. Meyer's professional life was undoubtedly his overshadowing interest in thoracic surgery. With this he will remain permanently identified as the prime mover and founder of this specialty in America. In his address on the history of thoracic surgery at the New York meeting of the Association in 1927 (*Archives of Surgery* **16**: 360, 1928) Dr. Meyer stated that the years from 1896 to 1904 might be regarded as the nascent period of thoracic surgery as a special division of surgery. In 1908, the movement towards organization took a more definite shape at the International Symposium held, under the chairmanship of the writer, by the Surgical Section of the American Medical Association at Chicago. But it was not until 1917, when Dr. Meyer, with a group of congenial associates and workers founded both the New York Society and the American Association for Thoracic Surgery, and it was then that the surgery of the chest first claimed recognition as a distinct specialty of surgery.

Dr. Meltzer presided over the first session of the Association in 1919, and was followed by Dr. Meyer who continued in office during the two succeeding years, 1920-21. These dates are merely mentioned to recall that as far as 1904 Dr. Meyer participated in every important meeting and event that promoted the interests of thoracic surgery, and that, from then on, his thoughts and constant efforts were directed towards the development of thoracic surgery by overcoming the obstacles that stood in the way of its free and unrestricted access to the contained organs.

During these years he had the satisfaction of participating in the vast progress accomplished and, though his own achievements and those of other distinguished workers in the same field, he demonstrated that the surgery of the chest had come of age and in so doing developed its own problems; that these required a special culture and training to deal with them effectively, and that, in this sense, thoracic surgery was as much entitled to rank with the surgery of the abdomen and cranium as a distinct specialty.

It would be impossible to do justice to the articles that Dr. Meyer contributed

to thoracic surgery. They are a part and a parcel of its history as this has evolved in the United States during the last three decades. The following will suffice to attest to his inexhaustible activity and productivity.

"Pneumectomy With the Aid of Differential Air Pressure"; "An Experimental Study" (1909); "Some Observations Regarding Thoracic Surgery on Human Beings" (1910); "On Drainage After Intrathoracic Operations With Special Reference to Resection of the Esophagus" (1912); "The Surgical Treatment of Cancer of the Esophagus" (1913); "The Early Diagnosis of Cancer of the Esophagus" (1913); "The Surgery of the Pulmonary Artery" (1913); "On Bronchiectasis" (1914); "Resection of the Cardia for Carcinoma" (1915); "Post-Operative Thoracic Drainage" (1918-19); "Transthoracic Laparotomy" (1919); "The Operative Treatment of Advanced Pulmonary Tuberculosis" (1920); "Fundamental Principles of Thoracic Surgery" (1921); "The Establishment of a Temporary or Permanent Pulmonary Lip-Fistula in the Conservative Treatment of Advanced Bronchiectatic Lung Abscess" (1922); "Observations on Lung Suppuration and Its Treatment" (1923); "The Future of Thoracic Surgery" (1925); "Thoracic Surgery in America: Retrospect and Outlook" (1928); and "Primary Cancer of the Lung" (1928).

Here then, we see all the material assembled for a treatise on the surgery of the chest in its latest and most advanced phases. It is possible, had he lived, he would have published such a treatise, for which no one was better fitted or invested with greater authority.

At the time of his death Dr. Meyer was Emeritus Professor of Surgery in the New York Post-Graduate School, consulting surgeon to the nine hospitals previously mentioned, a Senior Fellow of The American Surgical Association; Fellow of the American Medical Association, American College of Surgeons, American Association for Thoracic Surgery, New York Surgical Association, New York Academy of Medicine, New York Association for Thoracic Surgery (President, 1920-21), American Gastroenterological and American Urological Associations, American Association for Cancer Research (President, 1922-23), New York State and County Medical Societies, New York Pathological, and numerous other medical societies; also a member of the Deutsche Gesellschaft f. Chirurgie and the Deutsche Gesellschaft f. Urologie.

He was married in New York City, April 29, 1885, to Lilly Ottilie Maass, who died on December 8, 1928; they had four children, of whom the two youngest are living, Marjorie Fanny, wife of Franz G. Flemming, and Herbert Willy Meyer, M.D.

The dramatic, but fitting circumstances which marked the close of Dr. Meyer's distinguished career at the New York Academy of Medicine on February 24, 1932, have been told elsewhere in this journal in a very inadequate, but heartfelt expression of admiring appreciation.

RUDOLPH MATAS.

Original Communications

ACUTE EMPYEMA*

GEORGE J. HEUER, M.D.
NEW YORK CITY

SO MUCH has been written about acute empyema in the recent literature, that one wonders what there is left to say about it. The subject continues to be a live one, I believe, chiefly because of the variations in its clinical manifestations, the number and variety of its methods of treatment, and the variations in its mortality. In spite of what we have thought to be great advances in the management of the disease, the mortality in acute empyema continues in general to be fairly high. Moreover, with the consistent use of improved methods, the mortality shows great variations, for in a series of cases treated in certain years it may be zero; in another series treated in other years it may be as high as 50 per cent. The great variations in the mortality are disturbing, in view of what seem to be fairly well established methods of treatment and one is prone to relate them too largely, perhaps to these methods. Rather than lay too much stress upon operative procedures to explain our apparent failures, we might inquire more closely into the manifestations of respiratory infections, of which empyema is one. Such an inquiry I propose to make in the following pages.

Since respiratory infections come within the field of the internists and since the diagnosis of empyema has usually previously been made by them, surgeons naturally have been most interested in its treatment. They have directed their attention toward perfecting methods of properly draining the intrapleural infection and of insuring rapid healing of the condition; and of accomplishing both with as low a mortality as possible. Before the war, the consensus of opinion was that a properly placed rib resection with open drainage of the pleural cavity, best met the indications, and that with the exception of pulmonary gymnastics tending to inflate the partially collapsed lung, postoperative treatment aided nature but little in the healing of the condition. The distinction, from the standpoint of treatment, between postpneumonic pneumococcic empyema and postinfluenzal streptococcic empyema was rarely made and both groups of cases were treated by the same method. The mortality in general, varied between 15 per cent and 25 per cent, the time required for the healing of the condition varied greatly and the end-results in those who recovered showed that about 20 per cent of the cases of acute empyema became chronic and required further operative measures for their cure.

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The epidemic of influenza in the army camps during the past war, give a great impetus to the study of acute empyema. Pathologically, bacteriologically and clinically, the disease showed great variations from the usual postpneumonic empyema; and when, in the early days of the epidemic, the same method of treatment (rib resection and open drainage) was used, the mortality in different army camps was over 60 per cent. The unexpectedly high mortality led to a series of investigations by Graham and Bell and others, which now are so well known that they need not here again be detailed. The results of these studies showed the disadvantages, in streptococcic empyema, of producing an open pneumothorax in the presence of a pneumonic process in one or both lungs and led to the adoption of a method of treating acute empyema which consisted of early aspiration, followed if necessary, by late thoracotomy. The important feature of this method, was that it prevented an open pneumothorax at a time when the vital capacity of the individual was dangerously low, due to the pneumonic process; and that it was of great importance as a principle in the treatment of acute empyema seemed indicated by the great decline in the mortality rate. That this decline was wholly due to the adoption of a new method of treatment, as suggested by many, I have never believed and shall state the reasons for my disbelief directly; but that the principle remains an important one, seems to me unquestioned. But in addition to this contribution, the interest in empyema during the war was largely responsible not only for the idea of individualizing empyemas from the viewpoint of their pathology and treatment, but for a reawakening of interest in their postoperative treatment. As a result of the former, a more intelligent program for the management of a given case of empyema is possible; as a result of the latter, chronic empyema can be and has been, practically eliminated in many clinics.

The experience which has accumulated since the war makes it appear that too high hopes were placed in primary aspiration with late thoracotomy and closed aspiration drainage as the treatment for acute empyema. It has been the experience of many, ourselves included, that in spite of the use of one of these methods the general mortality remains discouragingly high. Those who have never approved of them now find themselves vindicated, while some of those who enthusiastically adopted them have gone back to primary rib resection and from a comparison of their results again favor primary open drainage. The emphasis, in the appraisal of results, has been placed, as so often in the past, upon the operative procedures; and it becomes proper to inquire whether the procedures are at fault or whether we have misinterpreted our clinical results. A study of the clinical and pathologic manifestations of respiratory infections giving rise to empyema, based upon two fairly large series of cases, may shed some light upon these questions.

Acute empyema is rarely a primary disease, but is rather a complication of a variety of antecedent conditions. It may occur secondary to external thoracic injuries, as gun shot or stab wounds; to internal thoracic accidents as perforation of the esophagus, to abdominal infections as peritonitis, subphrenic and hepatic abscess, to pulmonary tuberculosis and to acute respiratory infections as influenza and pneumonia. I shall omit any detailed consideration of empyemas the result of thoracic injuries, of accidents within the thorax, of abdominal infections and of tuberculosis, and confine my discussion largely to the commoner forms of empyema following respiratory infections.

The respiratory infections which commonly give rise to empyema may roughly be divided into two large groups, pneumonia and influenza. Their clinical manifestations, their pathology and their mortality, differ from one another and, in each group, differ from year to year. So too, do the manifestations of the empyemas which complicate them often differ. In lobar pneumonia the empyema usually follows the disease, appearing after the pneumonic process has subsided; in influenza, it usually appears coincidentally with the pneumonic process. There is, therefore, a difference in the time of appearance of the empyema with respect to the pneumonic process in the lungs, a circumstance which has an important bearing on the treatment of empyema. The symptoms in the two groups of cases may vary greatly. In empyema following pneumonia they are often comparatively mild. The patient may indeed have a distressing cough, a septic temperature, unpleasant sweats and lose weight; but in an uncomplicated pneumococcic empyema he may live on for months until mediastinal pressure symptoms or some accident overcome him. In empyema following influenza the symptoms are often far more severe; a high grade of toxemia, rapidity of the pulse, urgent respiration and the general appearance of the patient, all suggest that he is desperately ill. Indeed his symptoms seem out of proportion to those we expect from a simple empyema and suggest some additional grave condition; and should he die, as he may early in the disease, necropsy will often reveal a bilateral lobular pneumonia, pericarditis or some equally serious lesion. It is not implied that there is always this striking dissimilarity in the two groups of cases. The postpneumonic empyemas may present the grave symptoms of the postinfluenzal empyemas and at necropsy may show quite similar lesions; again the postinfluenzal empyemas may present quite as mild symptoms as the postpneumonic empyemas. The question, then, often arises in both groups, whether the severity of the symptoms is due to the empyema per se or to additional complications the result of the respiratory infection.

Not only do the symptoms of the two groups vary from each other but the symptoms of each group vary from year to year. It must be familiar to all of you that both the postpneumonic (pneumococcic) and

the postinfluenzal (streptococcic) empyemas may in a given year be mild infections and give rise to symptoms which might be expected in a simple intrapleural abscess; in another year they may be severe and fulminating and by their multiplicity or severity suggest the presence of conditions other than, and in addition to, empyema. Necropsy examinations in those dying with severe symptoms usually confirm the clinical findings as I shall presently show.

Bacteriologically the organisms found in the pleural exudate in the two groups of empyemas are different. In the postpneumonic empyemas strains of pneumococci are the only or the predominant organisms; in the postinfluenzal empyemas the streptococci are the predominant organisms. Mixed cultures of pneumococci and streptococci or staphylococci may occasionally occur. It is, of course, well known that the type of infecting organisms is in part responsible for the variations in the pathology of respiratory infections and, therefore, to the variations in their symptomatology. It is also well known that the virulence of the organisms or the virulence-resistance ratio between organism and individual varies in different localities and in the same locality in different years.

The exudates the result of the pleural inflammation also are different in the two groups of cases. In the postpneumonic empyema the exudate is thick, purulent and contains large amounts of fibrin; in the postinfluenzal empyema it is thin, serous, hemorrhagic or slightly purulent and with comparatively little fibrin. The difference has considerable significance; for aside from its diagnostic importance is the fact that the plastic exudate of postpneumonic empyema will probably contribute toward the stabilization of the mediastinum, while the serous exudate of postinfluenzal empyema will fail to do so. From the standpoint of operative procedure this is of some importance.

The *pathology* of acute empyema need not be fully discussed, but it is important to consider the various pathologic manifestations of respiratory infections of which empyema is one. It should be clearly recognized that in the empyemas we are called upon to treat we meet two entirely different groups of pathologic manifestations both in the postpneumonic and postinfluenzal empyemas. In the one, we have to do with a simple straightforward empyema unassociated with other discoverable pathologic conditions; in the other, with a complex variety of conditions which, in addition to empyema, include bilateral bronchopneumonia, contralateral empyema, single or multiple pulmonary abscesses, pericarditis, mediastinitis, peritonitis, meningitis and septicemia.

The simple uncomplicated empyema does not require an extensive pathologic description. It is an intrapleural abscess of varying size and location, the outer wall of which is formed by the bony thorax, the inner wall by the partly compressed lung, the mediastinum or the

diaphragm. The lining of the abscess—the parietal and visceral pleurae—shows varying grades of inflammation and thickening, depending upon the type and duration of the infection. The contents of the abscess have just been described and their differences noted in the postpneumonic and postinfluenzal infections. It is possible, and indeed, sometimes true, that absorption from the large area of inflamed pleura may give rise to such a grave degree of toxemia that death

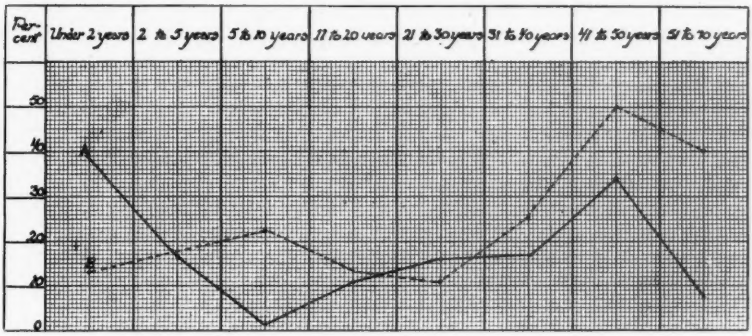

Fig. 1.—Mortality in empyema according to age groups. *A*, Baltimore series. *B*, Cincinnati series.

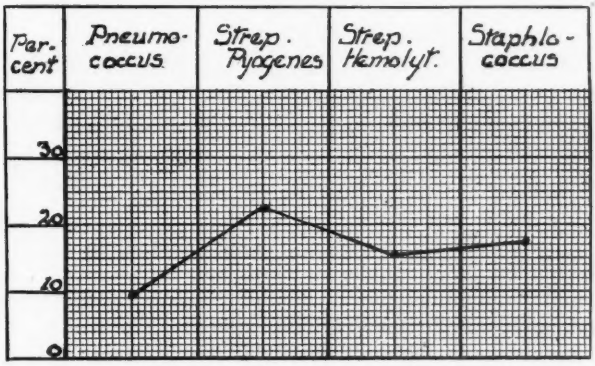

Fig. 2.—Mortality in empyema according to the kind of organisms found in the exudate. (Baltimore series.)

ensues; but that this is common would appear doubtful from necropsy examinations in properly treated cases. This is the condition for which operations for empyema are intended and toward which they are directed; and whether they consist of rib resection with open drainage or closed aspiration drainage, they are fairly successful when judged by their mortality. In a series of 425 cases of empyema occurring at the Johns Hopkins Hospital between October, 1889, and January, 1921, treated almost exclusively by *rib resection and drainage*,

the mortality in all acute empyemas in which no other lesion except empyema was demonstrable by physical, x-ray or necropsy examination, was less than 6 per cent; in certain groups of cases (60 cases between five and ten years) it was 0. In 68 of a series of 158 cases of acute empyema occurring at the Cincinnati General Hospital from 1922 to 1930 in which physical, x-ray or necropsy examination failed to show a pathologic condition other than empyema, the mortality with *closed aspiration drainage* was 1.4 per cent.*

In contrast to the simple uncomplicated empyemas is the second group which presents in addition to empyema the pathologic conditions I have enumerated. The infection is more severe; and whether the lung and various serous surfaces are attacked simultaneously or not, the result is a number of pathologic conditions which vary in their multiplicity, character and seriousness and of which empyema is usually by far the most benign.† It is a question whether the fate of many of these cases is not determined before the empyema is surgically attacked. Certain it is that the mortality, whether following thoracotomy with open drainage, or closed aspiration drainage, occurs in very large measure in this group. In the Johns Hopkins Hospital series of 425 cases treated by rib resection and drainage there were 72 deaths, a mortality of 16.5 per cent.** Studied from the viewpoint of age groups I

*The single death was due to tension pneumothorax, the result of the withdrawal of the tube. (Patient pulled the tube out.)

†But it is of interest to inquire whether these various pathologic conditions including empyema are to be interpreted as manifestations of the respiratory infection or as secondary to, and the result of, the empyema. The view has been offered by some that these pathologic conditions follow, and are the result of, the empyema; and the fact that they have been present more often in cases treated by closed aspiration drainage than by open drainage in a series of cases, is considered sufficient reason for advocating primary open drainage in infants on the assumption that it provides better drainage. Unfortunately, we cannot be certain about the matter in all cases. In the fulminating postinfluenzal streptococcic infections, the pneumonia, empyema, pericarditis, mediastinitis, peritonitis and so forth, found in different combinations in cases dying in the first week of the disease in the army camps must all, I think, be interpreted as manifestations of the respirtatory infection. In similar cases before and since the war the same assumption seems sound. In certain cases of pneumococcic infection it also seems probable, for the disease is rapidly fatal, may be associated with septicemia and presents at necropsy similar pathologic conditions. In other pneumococcic empyemas the relationship does not seem so clear; for it is true that the empyema may for a long time be unrecognized or untreated, that the complicating conditions seem to appear or to be recognized after the empyema has been recognized and treated and that, therefore, they may be the result of, and secondary to, the empyema. Necropsy examination in those dying comparatively late in the disease does not help us as greatly as we could wish in determining the matter. Yet certain findings seem to me significant. In cases of empyema dying late (ten to thirty days after operation) there usually occurs before death signs of an overwhelming infection as indicated by a not uncommon septicemia. At autopsy there are the findings of a drained empyema, a unilateral or bilateral pneumonia (usually lobular), pericarditis, contralateral empyema and so forth. In a study of the autopsy records of the Baltimore series I fail to find an instance in which the lesions, such as pericarditis, contralateral empyema, pulmonary abscess, etc., may not as well be explained upon the basis of a pneumonia and a septicemia, as upon the basis of the empyema. The same is true of the Cincinnati series. The burden of proof it seems to me lies with those who assume that these conditions are secondary to the empyema. To me they seem more often to be manifestations of the respiratory infection. The reason for discussing the matter is to call attention to what shall be the primary object of our therapeutic efforts; i.e., whether it is primarily to save life or to disregard this in favor of averting possible late complications of empyema which may lead to death. An operative procedure which achieves the second object must also achieve the first, to have any merit.

**The series includes 12 cases of posttraumatic empyema, 17 postoperative, 35 associated with pulmonary tuberculosis, and 11 with a miscellaneous group of infections. If we exclude these and confine ourselves only to empyema following respiratory infections the mortality is 11.4 per cent. The cases are well scattered and do not seriously affect the statements nor the graphs made in regard to the Baltimore series.

found that in 41 children under two years of age there were 16 deaths, with 10 necropsy examinations. In every instance in which a necropsy examination was made one or several of the pathologic conditions I have enumerated were present, in addition to the empyema. In the six cases dying without necropsy examinations symptoms and physical signs suggested serious complications in addition to empyema. In 76 children from two to five years of age there were 13 deaths with 12 necropsy examinations, and with exactly similar findings. In 62 children from five to ten years of age there were 3 deaths with necropsy examinations and again with similar findings. It is unnecessary to continue through the list.* From my study of this series of cases it is clear

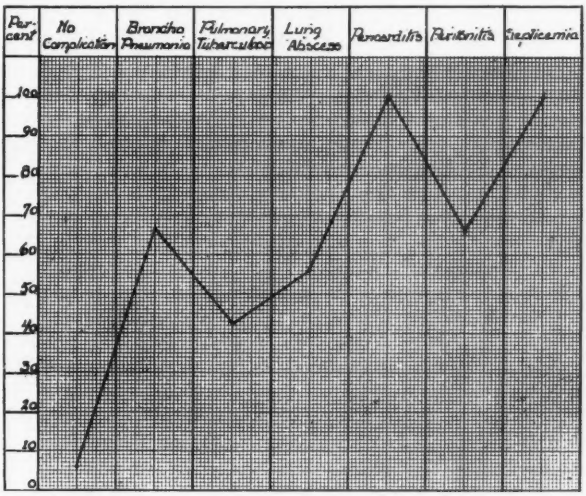

Fig. 3.—Mortality according to various pathologic conditions associated with empyema. (Baltimore series.)

that patients dying after operation for empyema showed at necropsy almost without exception some serious pathologic condition in addition to empyema. The mortality as may be seen from the accompanying charts (Figs. 1, 2 and 3) varied according to age, according to the type of infection (pneumococcic, streptococcic, etc.), and according to the kind and number of pathologic conditions present in addition to empyema. It varied from year to year in both the pneumococcal and streptococcal empyemas. These variations in the mortality can in large measure all be traced to, and explained by, the pathologic conditions other than empyema which occurred in different age groups,

*In 64 patients between eleven and twenty years of age, 7 deaths; in 90 between twenty-one and thirty, 14 deaths; in 56 between thirty-one and forty, 10 deaths; in 23 between forty-one and fifty, 8 deaths; and in 13 between fifty and seventy, 1 death. Practically without exception patients in these various age groups dying presumably from empyema showed some serious pathologic condition in addition to empyema.

in different types of empyema, and in different years. Neither the operation which was always the same (thoracotomy with open drainage) nor the empyema itself explains the variations in the mortality.

A study of my Cincinnati series allows an interesting comparison with the Baltimore series. Between 1922 and 1930, 158 cases of acute empyema secondary to respiratory infections have been treated at the Cincinnati General Hospital. The treatment was primarily and without exception closed aspiration drainage, while in the Baltimore series, as noted, it was thoracotomy with open drainage. The mortality for the entire Cincinnati series was 22.7 per cent; a mortality higher by 6 per cent than in the Baltimore series. In the Cincinnati series the mortality in 1922 was 0; in 1923, 7.7 per cent; in 1924 and 1925, 14.3 per cent; in 1926, 28.6 per cent; in 1927, 53.3 per cent; in 1928, 39 per cent; in 1929, 9 per cent and in 1930, 10 per cent (Fig. 4). Accord-

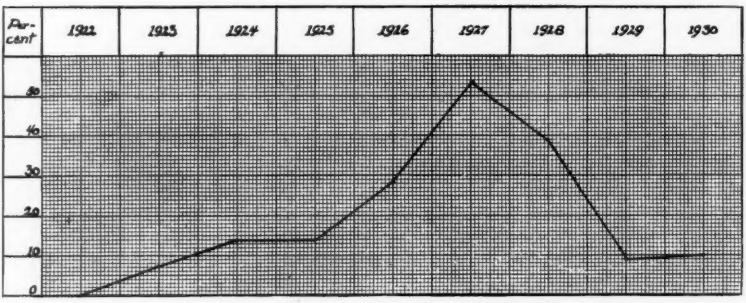

Fig. 4.—Mortality by year periods in 158 cases of acute empyema treated by closed aspiration drainage. (Cincinnati series.)

ing to age groups the mortality in infants under two years was 16.6 per cent; from two to 10 years, 20.7 per cent; from ten to twenty years, 8.3 per cent; from twenty to thirty years, 18.6 per cent; from thirty to forty, 31.5 per cent; from forty to fifty, 40 per cent; from fifty to sixty, 12.5 per cent and over sixty, 63.6 per cent. A curve superimposed upon the curve of the Baltimore series shows the variations in the mortality in different age groups in the two series of cases (Fig. 1). The relationship between the mortality and the presence of pathologic conditions other than empyema is the same as in the Baltimore series. In 68 cases of acute empyema in which physical, x-ray and necropsy examination failed to show a serious pathologic condition other than empyema the mortality was 1.4 per cent*; in 90 cases in which pathologic conditions in addition to empyema were proven by physical, x-ray or necropsy examination the mortality was 38.8 per cent. A study of the series according to the type of empyema (pneumococcic or streptococcic) shows the very high incidence of streptococcic empy-

*An accident as previously noted; the mortality should have been 0.

ema in certain years. In 1922, 20 per cent of the cases were streptococcic empyema; in 1923, 23 per cent; in 1924, 21.4 per cent; in 1925, 28.6 per cent; in 1926, 52.4 per cent; in 1927, 66.7 per cent; in 1928, 64.2 per cent; in 1929, 54.5 per cent; in 1930, 33.3 per cent (Fig. 5). Not only did the percentage of pneumococcic and streptococcic empyemas vary from year to year, but the severity of the infection in each group varied from year to year. If the occurrence of multiple pathologic conditions is taken as an index of the severity of the infection then it appears, in the streptococcic empyemas, that demonstrated serious pathologic conditions in addition to empyema occurred in 1922 in 0 per cent; in 1924 in 7.7 per cent; in 1925 in 14.3 per cent; in 1926 in 33.3 per cent; in 1927 in 46.6 per cent; in 1928 in 33.3 per cent; in 1929 in 16.6 per cent and in 1930 in 0 per cent. The mortality curve follows not so much the type of infection as it does the incidence of serious

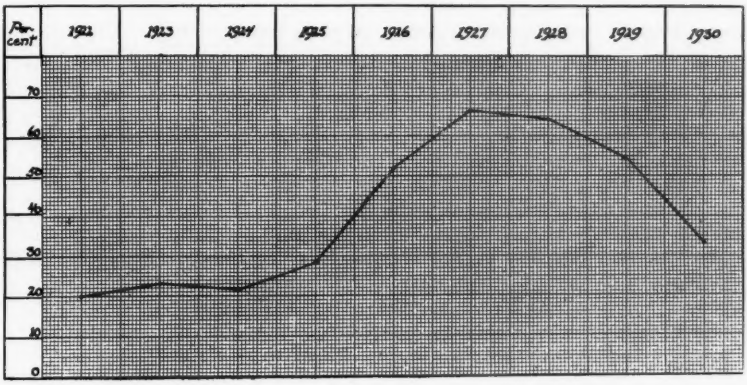

Fig. 5.—Incidence by year periods of streptococcic empyema in 158 cases. (Cincinnati series.)

pathologic conditions associated with the infection (Fig. 6). All these findings lead to the same conclusions at which we arrived in studying the Baltimore series; that is, that respiratory infections vary in type and in virulence in different localities and in the same locality in different years; that the patholic conditions to which they give rise, may be a simple empyema or an empyema associated with other serious conditions; that the mortality in empyema varies in different age groups, in different types of infection, in different localities and in different years; and that these variations in the mortality are dependent in greater degree upon the incidence of pathologic conditions other than empyema than upon the empyema itself, or the kind of operation performed. The comparsion between the Baltimore and Cincinnati series shows the far higher incidence of postinfluenzal streptococcic empyema in the Cincinnati series; and, since this type of infection is

more prone to give rise to a higher incidence of complications in addition to empyema it is, therefore, associated with a higher mortality.

It has been of interest to analyze not only the mortality in empyema but the mortality in the pneumonias occurring at the same time. My records do not enable me to do this for the Baltimore series, but through the courtesy of the Medical Department I have been able to do so for the years 1922-1927 in the Cincinnati series. In a series of about 1200 cases the mortality from pneumonia in the wards of the Cincinnati General Hospital was 25 per cent in 1922 and 1923; 30 per cent in 1924; 25 per cent in 1925; 31 per cent in 1926; and 50 per cent in 1927. A graph of the mortality percentages in pneumonia and empyema follow each other fairly closely (Fig. 7); and it seems from our experience that a virulent type of pneumonia with a high mortality

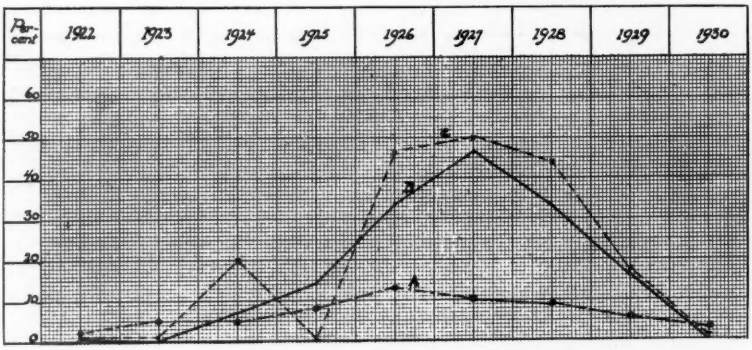

Fig. 6.—Composite chart showing relationship between the number of streptococcic empyemas, the incidence of serious pathologic conditions other than emypema and the mortality rate. (Cincinnati series.) *A*, Number of streptococcic empyemas; *B*, percentage incidence of serious pathologic conditions in addition to empyema; *C*, mortality percentage in streptococcic empyema.

whether of the pneumococcic or streptococcic type, will be associated with or followed by empyema complicated by other serious conditions and with a high mortality.

The experience in the army camps during the influenza epidemic of 1917-1919 may be included in this discussion. In 332 cases of post-influenzal empyema, fatal during the first week of the disease, 87 per cent had coexistent bilateral bronchopneumonia, 34 per cent pericarditis, 14 per cent peritonitis, 13 per cent mediastinitis and so forth. In other words, serious pathologic conditions in addition to empyema occurred as they did before the war and as they have since the war; although the incidence of these complications in 1917 and early 1918 was unusually high. The operative therapy in the associated empyemas consisted, in the early period of the epidemic, of thoracotomy with open drainage and was followed by a high mortality. It was changed

to early aspiration followed at a later period, if necessary, by thoracotomy, a method of procedure which was followed by a surprising fall in the mortality. At Fort Riley, for example, in 85 cases treated between October, 1917, and January, 1918, by early thoracotomy, there was a mortality of 61.2 per cent; in 96 cases treated between January and August, 1918, by early aspiration and late thoracotomy, there was a mortality of 15.6 per cent; and in a third series of cases treated between October, 1918, and February, 1919, by early aspiration and late thoracotomy (the same treatment as in the second series) there was a mortality of 9.5 per cent. These and similar results have been interpreted by some as due to the kind of operation performed and as indicating the great advantages of closed over open drainage. This interpretation surely cannot wholly be correct. The cases occurred at dif-

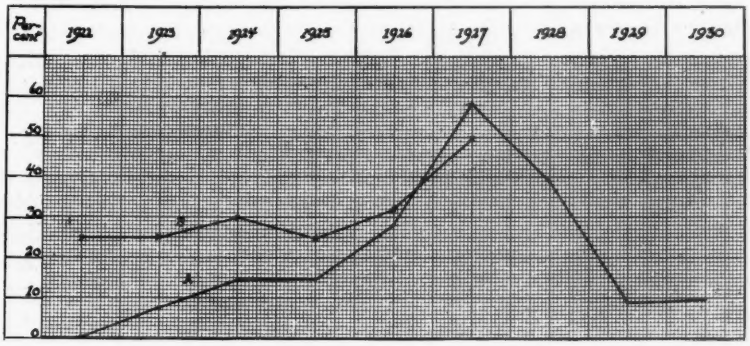

Fig. 7.—The mortality curves of empyema and pneumonia by year periods. (Cincinnati series.) *A*, Mortality rate in empyema by year periods; *B*, mortality rate in pneumonia by year periods. (The mortality in pneumonia for 1928, 1929, and 1930 not determined.)

ferent periods, there was a decline in the severity of the respiratory infection, a decline in the incidence of serious pathologic conditions associated with empyema and therefore a decline in the mortality, in part, quite independent of the type of operation performed. With the same method of treatment there was at Fort Riley a difference in the mortality in different series at different periods of about 40 per cent; and in our experience at Cincinnati we have observed in different years as great a difference in mortality in streptococcic empyema when closed aspiration drainage alone was used as was observed in the army camps when aspiration with late thoracotomy was substituted for early thoracotomy. (See Fig. 4.)

The foregoing analyses have been made with the purpose of pointing out: (1) That there is great difficulty in comparing, with the view of determining the relative merits of different operative procedures, dif-

ferent series of cases of empyema occurring in different localities, in different years, and treated by different methods unless all the circumstances are accurately determined and properly weighed. It is doubtful whether any real contribution to the comparative value of various methods of treatment will be made by statistical studies until cases are compared which have the same pathology.

(2) That the method of treatment is not wholly responsible for the favorable results obtained in some cases of empyema nor wholly responsible for the variable and generally high mortality in other cases. As has been shown the mortality in simple empyema, if properly drained, is low and is so whether drainage is open or closed. The mortality in empyema associated with other serious pathological conditions is generally high and is so whether treated by open or closed drainage. Whether the mortality is studied with the view of determining its relation to time periods, age groups, kinds of operation or other circumstances, the presence of these other pathologic conditions intrudes itself as the chief cause of the mortality. Nevertheless it is our belief that the mortality in both groups of cases may be lowered by the right selection of a procedure in individual cases.

(3) That in order greatly to reduce the general mortality in empyema associated with other serious pathologic conditions the problem must be attacked at its source, that is, the respiratory infection. This is the problem of the internists. But surgeons should either be familiar with the advances the internists have made in the treatment of respiratory infections or retain their services after the condition has become surgical; for the respiratory infection often remains the major problem.

THE TREATMENT OF ACUTE EMPYEMA

Experience has taught us that acute empyema is rarely so urgent as to require treatment other than aspiration before a fairly comprehensive study of the condition can be made. Such a study should include the attempt to determine the nature of the respiratory infection, the type and the extent of the pneumonia which complicates it, the time of appearance of the empyema with respect to the onset of the disease, the type of the infecting organism concerned in the empyema, and the coincident presence of conditions other than empyema including unilateral or bilateral pneumonia, contralateral empyema, pericarditis, mediastinitis, peritonitis, meningitis, and septicemia. The determination of all these things is obviously not easy and sometimes quite impossible, particularly in infants and young children; but usually sufficient information may be obtained to divide the cases into two large groups, the postpneumonic, pneumococcic empyemas and the postinfluenzal streptococcic empyemas. Each group may again be capable of subdivision into two, the simple empyemas and the empyemas associated with other serious pathologic conditions.

THE TREATMENT OF THE SIMPLE ACUTE EMPYEMAS

As noted in our remarks about the pathology of empyema, simple empyema consists of an intrapleural abscess of varying size and location in an individual who so far as can be told by various methods of examination has no other serious pathologic conditions in association with it.* The typical pneumococcic empema is the best example of this condition; but the streptococcic empyemas may be quite similar. It is well known that as the virulence of the streptococcus declines, the lesions it gives rise to more and more resemble the pneumococcic lesions, including empyema. Indeed it has been our experience to be unable to differentiate the two types of empyema at the operating table; for the character of the pus and the appearance of the empyemic cavity have been so similar. Bacteriologically also, the differentiation is not always easy; and it is possible that mistakes have been made in the organisms isolated.†

While the two groups may be quite similar they may show variations in their manifestations. In our experience these variations concern chiefly the appearance of the empyema with respect to the pneumonia and the character of the exudate. In the streptococcic empyemas the empyema appears earlier and the exudate is thinner and contains less fibrin. These differences recall the statement made in previous pages that the exudate in pneumococcic empyema aids in stabilizing the mediastinum while that in streptococcic empyema is less likely to do so. This statement would appear to be true; but there are exceptions in both the pneumococcic and streptococcic empyemas. It has been my experience to produce an open pneumothorax by primary rib resection in streptococcic empyema, without the slightest symptoms of a cardiorespiratory upset either immediately or subsequently; again I have had the experience in simple pneumococcic empyema of producing by open pneumothorax a serious and an occasional fatal cardiorespiratory upset. It is difficult in a given case of simple empyema of either group (not walled off or localized) to determine whether the mediastinum is or is not stabilized.

The methods of treating acute empyema are chiefly three:

(1) Repeated aspiration without or with some subsequent procedure; (2) closed aspiration drainage, and (3) intercostal incision or rib resection with open drainage. The second method although old

*This is more or less idealistic; as a matter of fact the presence of a pneumonic process in the lung of the same side as that on which the empyema develops must often be missed as is shown by necropsy examinations. This fact may explain some of the deaths which occur in presumably simple empyemas of pneumococcic type treated by open drainage. In speaking of simple empyema I do so with the understanding that such a pneumonic process may be present.

†The question of the correct identification of the organism is an important one. It seems to us that our proportion of streptococcic empyemas in Cincinnati has been high. In conversations with some of the members of the medical service it appears that they think the proportion of streptococcic pneumonias has been high in comparison with other localities. In this paper we have accepted the findings of the clinical laboratory as given. In all cases the differentiation between the pneumococcus and streptococcus has been made by bile solubility and specific agglutination tests.

has again been reestablished as a result of the experience gained in the war and implies, at least in the early period of the disease, the drainage of the empyemic cavity without the production of a pneumothorax. With repeated aspiration we have had practically no personal experience. As the sole treatment of empyema it was formerly thought inadequate. Since the war, however, it has been found to have some curative value. Stone found that 11.3 per cent of his cases were cured, Graham that 10 per cent to 15 per cent (children) were cured and Ochsner and Gage that 33.3 per cent were cured. McEnery and Brennemann report that in 33 cases of empyema occurring in children 91 per cent recovered and 9 per cent died.* As a curative method of treatment it may, therefore, succeed; but it seems inevitable that it must occasionally or often fail. Should it do so it may be followed by rib resection and open drainage thus converting it into the method of early aspiration and late thoracotomy used in the army camps in the late war. Or it may be followed by closed aspiration drainage. In comparing this procedure or, as may often happen, this series of procedures, with the one procedure of closed aspiration drainage, several theoretical and practical considerations may be mentioned. Theoretically and practically both have the merit that they avoid an open pneumothorax in the presence of a possible coincident pneumonia and an unstable mediastinum. Theoretically the question arises whether repeated aspiration when succeeded by late drainage may not be followed more often by diminished function of the lung, by delayed healing or by chronic empyema, than immediate closed aspiration drainage. These are the other essentials (besides saving life) of a satisfactory procedure. So far as I can discover there are no published records from which an accurate comparison can be made, nor do our own enable us to compare them. Practically it would seem that if the procedures are equal in value one procedure is better than many and especially so if it is simpler than the summation of the many. Against the possible advantage of simplicity of closed aspiration drainage have been urged a number of disadvantages such as plugging of and leakage around the tube, and so forth. That these may be overcome and good results achieved from the viewpoints of mortality, functional disability and the development of chronic empyema may be seen from a study of our cases. In the Cincinnati series of 68 cases of simple empyema there was one death due to tension pneumothorax the result of the accidental withdrawal of the tube, a mortality of 1.4 per cent and a real mortaltiy from empyema of 0. The average time the tube was retained in the empyemic cavity was twenty-four days; the average time of complete

*Since this paper was written there has appeared (J. A. M. A., 1931, 96: 1453) the paper of Dr. Joseph A. Danna, "The Treatment of Empyaema by Aspiration and Air Replacement Without Drainage; Review of Thirty-five Cases." In this series 33 patients were cured and two died. This is an interesting contribution to the subject.

healing of the empyema (total obliteration of the cavity; complete healing of the wound) was less than thirty-nine days.* The immediate functional disability at the time of discharge from the hospital was practically nil. The late functional disabilities have not been determined. From the standpoint of the adequacy of drainage secured by this method when combined with irrigation our records show that 65 of the 68 cases healed completely without any further procedure and three were subjected to a subsequent rib resection. Two of the three cases had bronchial fistulas which made irrigation impossible and it was thought open drainage would facilitate healing. One case, for a cause not determined, progressed very slowly in respect to the obliteration of the cavity and was subjected to a rib resection in the hope of improving the situation. This case completely healed in 105 days, the longest postoperative course in this group of cases. From the viewpoint of time this case may be considered as a failure to prevent chronic empyema; from the viewpoint of the necessity of additional procedures to obliterate a cavity, chronic empyema did not occur. The complication of abscess of the thoracic wall has been referred to by a number of writers as a disadvantage of closed aspiration drainage. In the above group of simple empyemas there is not an instance of the development of such an abscess. But in the virulent streptococcic respiratory infections in which empyema has been associated with other serious pathologic conditions a number of such abscesses (6 in 90 cases) occurred.

Primary rib resection, unlike the two preceding methods, has the disadvantage that it produces an open pneumothorax in the early stages of empyema. There may be at this time a coincident pneumonia and an unstable mediastinum, circumstances which lead to cardiorespiratory difficulties and sometimes to death. It is well known that such circumstances are less prone to occur in postpneumonic than in streptococcic empyema, but that they may, and, in our experience, have occurred in both types, is undoubted. So far as I know we have no simple method of determining with certainty, in either type of empyema, whether or not the mediastinum is immobile before operation is performed; which raises the question whether, until such information is available, rib resection and open drainage should ever be the primary treatment in generalized empyema.† The great advantage claimed for rib resection and open drainage is that, if carried out at the most dependent part of the empyemic cavity, it achieves the most

*Thirty-nine days is the average time from the date of operation to the date of discharge from the hospital. Since it is our custom to retain patients for several days after complete healing has occurred the period is slightly less than thirty-nine days. These statements regarding healing apply to the cases of simple empyemas observed in the years 1922-1927 inclusive. The cases since that time have not yet been studied. Other statements made apply to the entire series of 68 cases of simple empyema.

†This statement does not, of course, apply to the localized empyemas, interlobar empyemas, etc.

satisfactory drainage. It is not claimed that as a primary procedure it immediately saves more lives than do the two procedures already discussed; its advantages are more remote in that it is more likely to prevent chronic empyema, and other complications as pericarditis, peritonitis, septicemia, and so forth. That adequate drainage is of the greatest importance in the prevention of chronic empyema is generally agreed, but that it may better be secured by rib resection than by closed drainage combined with irrigation is not proved in view of the experience cited above, and the experience of others. That such complications as bilateral bronchopneumonia, pericarditis, peritonitis, meningitis, septicemia, and so forth, are the result of the inadequate drainage of the empyema, also has not been shown to our satisfaction (see footnote page 466); but if they are, they are no more likely to be prevented by rib resection and open drainage than by closed drainage with irrigations, since the drainage secured by one may be quite as good as that secured by the other.

These are the considerations which should be weighed in the choice of the primary procedure for the treatment of simple acute empyema. Whether the choice be primary aspiration followed by rib resection, or closed aspiration drainage, or primary rib resection with drainage the mortality should be and practically is low. With the first procedure Graham* had no mortality in 76 cases of uncomplicated empyema, with the second we had no mortality in 68 cases of uncomplicated empyema and with the third, there was no mortality in certain groups (60 cases between five and ten years) of uncomplicated empyema, in the Baltimore series. There is, then, no question of greatly reducing the mortality by the adoption of a given method; the question rather is of averting an occasional and rare death due to open pneumothorax in the presence of an unsuspected pneumonia and a mobile mediastinum. That such an occasional death will occur sooner or later if primary rib resection with open drainage is routinely used seems certain from our experience; and in both the simple pneumococcic and streptococcic empyemas. The late results from the viewpoints of functional disability should also be good with all these methods. With proper drainage and with proper attention to postoperative treatment, chronic empyema should practically be eliminated.

THE TREATMENT OF THE ACUTE EMPYEMAS ASSOCIATED WITH OTHER SERIOUS PATHOLOGIC CONDITIONS

It has been pointed out that the common pathologic conditions associated with empyema the result of respiratory infections are uni-

*Surg., Gynec. and Obst., 38: 446, 1924. Whether these various groups of cases are exactly comparable cannot be definitely stated. The Cincinnati and the Baltimore series referred to are practically comparable; it is assumed that Graham's cases are comparable since he states that "not a single case has been fatal which was not accompanied by serious complications."

lateral or bilateral pneumonia, contralateral empyema, pulmonary abscess, pericarditis, mediastinitis, peritonitis, meningitis, and septicemia. It has been suggested that in the severe respiratory infections, whether of the pneumonic or influenzal type, these various conditions including empyema are more often manifestations of the respiratory infection than complications of the empyema. It has also been indicated that these various manifestations of respiratory infection are more prone to occur in the streptococcic infections than in the pneumococcic infections; but that they occur sufficiently often in the pneumococcic infections not to be disregarded. It has been suggested that such pathologic conditions may be taken as an index of the severity of the infection (streptococcic or pneumococcic) and that their incidence varies in different localities and in the same locality from year to year. It is, of course, obvious that under these circumstances the empyema becomes the constant condition, the others are variable conditions; and it seems from our experience that the mortality will depend in a large part upon the number and kind of these variable conditions. Of them all, pneumonia is the only one which might be termed a self-limited disease and, therefore, when it alone is associated with empyema, the mortality, provided the empyema is properly treated, may be expected to be lower than in the others. But as we have shown, the mortality for pneumonia unassociated with empyema is subject to great variations from year to year and may in certain years be as high as 50 per cent.

From these considerations the treatment of acute empyema associated with other serious pathologic conditions resolves itself into an attack upon the least dangerous condition with the purpose of lessening the load of infection which the invidual is carrying. It can have little effect of itself upon the pneumonia, pericarditis or other conditions from which the patient is suffering. The method of treatment under these circumstances, therefore, should be one which lessens the load without introducing conditions which immediately may be more serious than the empyema. It is in this respect that primary aspiration with late thoracotomy and closed aspiration drainage are, in our opinion, superior to immediate rib resection with open drainage; for they eliminate an open pneumothorax in the presence of a pneumonic process and an unstable mediastinum. Were it possible or advisable to determine before operation that the lung was fixed to the thoracic wall or the mediastinum stabilized by induration or adhesions, there would be little choice between procedures; but while methods of determining these conditions suggest themselves I know of no simple and safe method at the present time which might routinely be used. It is our belief that the use of aspiration with late thoracotomy or closed aspiration drainage immediately saves a certain number of lives, particularly

among those patients in whom pneumonia alone is associated with empyema and does so by producing conditions more favorable to the recovery from the pneumonia; lives which might be lost by the additional burden of an open pneumothorax produced by primary rib resection. How many lives are or have been saved cannot at present be accurately determined; but how many have been detrimentally affected and possibly lost by primary rib resection may be estimated from a review of such patients who immediately or soon after this procedure have shown a change in condition indicated by dyspnea, cyanosis, and tachycardia and who have died in this condition within 24 to 48 hours. The Baltimore series shows a number of such cases—and they were common enough early in the empyema epidemic in the army camps.

Practically, a comparison of the results of various methods in the treatment of acute empyema associated with other serious pathologic conditions cannot at present profitably be made. To get any accurate idea of the comparative value of different methods one would have to compare their results in different groups of cases; i.e., empyema plus unilateral pneumonia, empyema plus bilateral pneumonia, empyema plus pericarditis, etc. Further classifications would involve various combinations of associated conditions; i.e., empyema plus pneumonia plus pericarditis, etc. Other factors would have to be taken into consideration, such as the virulence of the infection; i.e., the death rate from the uncomplicated pneumonias prevailing at the time, etc. So far as I am aware no studies of this sort have been reported from different clinics where different methods have been used. In the Baltimore and Cincinnati series we have a few data but they too are insufficient. In 106 cases of empyema associated with other serious conditions in the Baltimore series there were 51 deaths, a mortality of 48.1 per cent; in 90 cases of empyema associated with other serious conditions in the Cincinnati series there were 35 deaths, a mortality of 38.8.* In the Baltimore series in which primary rib resection was the procedure employed empyema associated with pneumonia showed a mortality of 66.5 per cent, empyema associated with pulmonary tuberculosis 42.5 per cent, empyema plus lung abscess 56 per cent, empyema plus pericarditis 100 per cent, empyema plus peritonitis (pneumococcal) 66 per cent, and empyema plus septicemia 100 per cent. In the Cincinnati series in which aspiration drainage was used, empyema plus pneumonia gave a mortality of 35 per cent, empyema plus pericarditis 100 per cent, empyema plus septicemia 100 per cent. Associated con-

*These figures again show the influence of other pathologic conditions on the empyema death rate. Taken individually the mortality in simple empyema and in empyema associated with other conditions was respectively 5 per cent and 10 per cent lower in the Cincinnati series than in the Baltimore series; yet the general mortality for all cases of empyema was higher in the Cincinnati series than in the Baltimore series. The explanation lies in the fact that in the Cincinnati series 57 per cent of all the cases of empyema presented conditions other than empyema while in the Baltimore series only 25 per cent presented such conditions.

ditions such as lung abscess, pulmonary tuberculosis, peritonitis, etc., occurred too rarely (1 case each) in the Cincinnati series to have statistical value, but the mortality was 100 per cent. The suggestive result of this incomplete study is the difference in the mortality rate in empyema associated with pneumonia in the two series of cases; but no account is taken in them of the mortality rate of the pneumonias occurring at the same time.

It is obvious that, thus far, such success as has been achieved in the treatment of empyema associated with other serious pathologic conditions has been largely in the cases in which empyema is associated with pneumonia. Should the patients survive these conditions the problems in connection with the treatment of the empyema are the same as in those with simple empyema. In our experience (Cincinnati series) the convalescence has been longer than in the cases of simple empyema, and it has been complicated in six cases by abscess of the thoracic wall. Healing has, however, progressed in every case which recovered and without the development of chronic empyema. In the Baltimore series instances of chronic empyema occurred following rib resection but I am sure that with our present attention to operative and postoperative procedures they would not occur.

Enough has been said to suggest why in various clinics and at various times and using various methods, there is such a great variation in the general mortality in empyema associated with other serious pathologic conditions. Indeed this variation in the general mortality would appear inevitable in view of the variations in the manifestations of respiratory infections and, in part, regardless of the method used in the treatment of the empyema. Neverthless we believe that perhaps many individual lives are saved by the use primarily of one or the other method of closed drainage in this group of cases.

OTHER GENERAL MEASURES IN TREATMENT

In very ill patients in whom pneumonia and possibly other serious conditions exist, the various measures used in the medical treatment of respiratory infections should be employed, for, in these, the respiratory infection continues for the time to be the major, the empyema the minor problem. A high caloric diet was advocated during the war and should be given. Various conditions other than empyema may be surgically attacked. An occasional case with peritonitis may be saved by drainage. Two cases with pericarditis in our series were treated by pericardiostomy with drainage, one of which seemed to be recovering but died upon the sixteenth day from an acute massive hemorrhage from the pericardium. With convalescence heliotherapy is of great benefit; and pulmonary gymnastics instituted early seem to lessen the tendency to retraction of the thorax.

THE HEALING OF ACUTE EMPYEMA

The immediate saving of life is of course the first and important step in the treatment of empyema; but this should be followed by efforts to induce rapid healing of the condition. Empyema of the thorax cannot be said to be cured until the empyemic cavity is entirely obliterated and the sinus tract healed. In 1923 I emphasized the fact derived from a study of the Baltimore series that the continuance of the infection within the empyemic cavity was the most important cause for the failure of empyema to heal; and Keller, Hedblom and others have stated the same thing in another way, by saying that inadequate drainage is the most common cause of chronic empyema. The securing of adequate drainage is then the first and most important step in the postoperative treatment of empyema. How it may best be secured is a matter upon which opinions differ. It is to be pointed out that rib resection does not necessarily secure it, for older statistics from various hospitals show an incidence of chronic empyema with this method of about 20 per cent; closed aspiration drainage does not necessarily fail to secure it, as our records, quoted above, indicate. It is not methods, but the proper use of a method, which is important. The question of the use of various irrigating solutions as an aid in overcoming the infection or in securing better drainage, is another upon which authorities differ. According to some, such solutions have little or no value in aiding the healing of empyema, according to others, they have great value. Meanwhile, the number of solutions advocated continues to increase. The quinine derivative, ethylhydrocuprine or optochin, bile and bile salts have more recently been advocated and favorable results reported. Here again is no matter for serious discussion. The common object is to secure rapid healing with a minimum of functional disability and the elimination of chronic empyema. If one observer can, without irrigations, secure the complete healing of empyema within thirty to forty days without the occurrence of chronic empyema, he cannot be blamed for not using them; on the other hand, he should not be too severe with another, who achieves the same results with irrigations. To me, Dakin's solution is a valuable adjunct; it is a mechanical irrigant, an antiseptic and a solvent of fibrin and necrotic tissue. It undoubtedly is of great value in combating infections and in the healing of wounds elsewhere and in our experience has a similar value in the treatment of empyema.

The return of the partially collapsed lung to the thoracic wall forms an important part in the healing of empyema, for it contributes in large part to the obliteration of the empyemic cavity. The other two factors, the retraction of the thoracic wall and the elevation and fixation of the diaphragm, are undesirable from the viewpoint of functional disability of the lung and should if possible, be avoided. The return

of the lung to the thoracic wall proceeds only if the infection is overcome, for otherwise, unhealthy granulation tissue, dense adhesions and a thickened pleura, the result of the infection, halts this process. It has generally been assumed that the process by which the lung reaches the thoracic wall is a reexpansion due to factors within the lung, and, therefore, that periodic increase in intrapulmonic pressure obtained by the use of Wolf bottles, aids in the reexpansion. It is a question not yet settled, whether in the obliteration of the empyemic cavity, the lung reexpands in this sense or whether it reexpands through traction exerted outside the lung. It is, of course, true that when watched

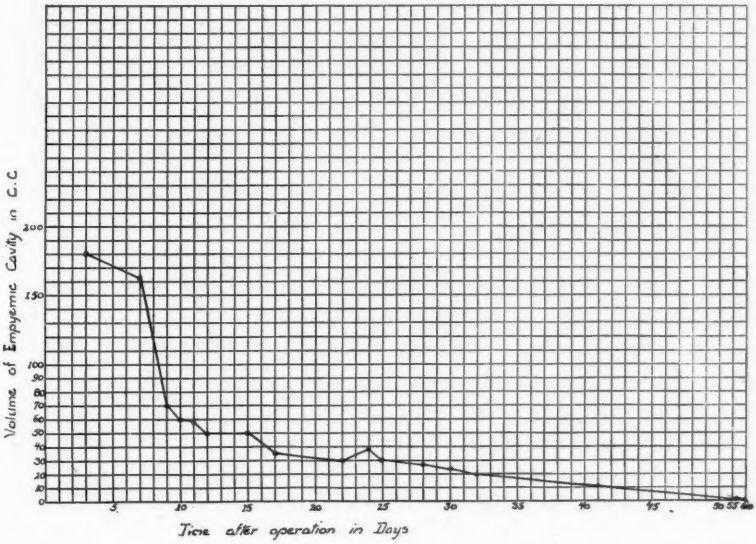

Fig. 8.—Exact copy of chart in case J. T., Cincinnati General Hospital, O-11507, child, two and one-half years old. Aspiration drainage. Irrigations with Dakin's solution. Cavity obliterated and wound completely healed.

through a thoracic opening the lung may be seen to expand when the intrapulmonic pressure is increased, but it immediately sinks back to its original position. It is also true that the lung, under this form of exercise, gradually approaches the thoracic wall; but that its gradual approach is due to the reexpansion of the lung from within or that it is greatly aided by the periodic increased distention of the lung is not clear. Certain observations are against this view. Clinically, it is well known that with an open pneumothorax and with a thoracic opening larger than the diameter of the trachea and with, therefore, an intrathoracic pressure equal to atmospheric pressure, the lung will gradually return to the thoracic wall, if adequate drainage is secured,

without the use of any method of increasing the intrapulmonic pressure. When primary rib resection was the routine procedure in the treatment of acute empyema, it was observed in some cases, that with the evacuation of pus, the lung immediately expanded, but promptly stopped expanding; and thereafter there was no similar rapid expansion of the lung but a slow, gradual approach of the lung to the thoracic wall. In other cases (and usually cases of longer duration) this primary expansion of the lung failed to take place and indeed could not be induced by raising the intrapulmonic pressure; and the gradual return of the lung to the thoracic wall proceeded without this prelimi-

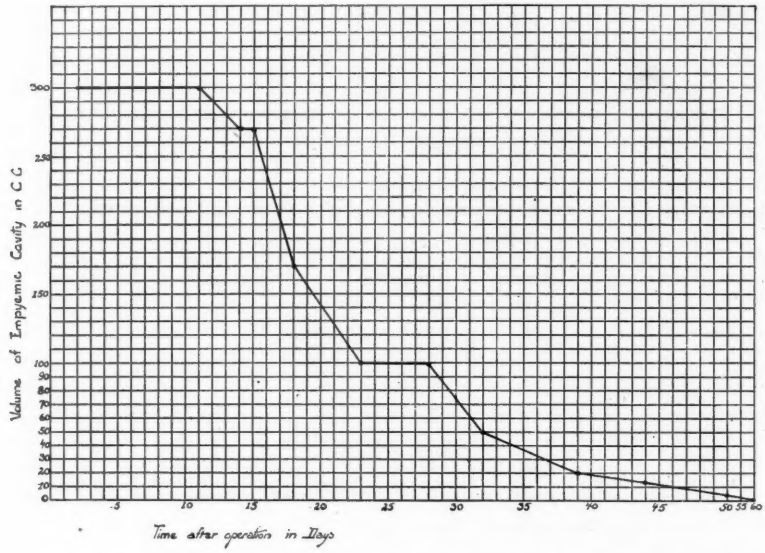

Fig. 9.—Exact copy of chart in case of B. F., Cincinnati General Hospital, P-1893, white, female, aged forty. Aspiration drainage. Irrigations with Dakin's solution. Estimated days for healing from formula; maximum, sixty-five days; actual healing time, sixty days.

nary event. Whether this preliminary expansion which takes place in some cases is of the nature of an elastic recoil of a compressed lung or due to the filling with air of atelectatic alveoli, I do not at present know; but that it plays any considerable or fundamental part in the process of the obliteration of the empyemic cavity seems very doubtful. In chronic empyema, somewhat similar observations may be made. With the thoracic wall widely opened (Keller's Method), the thickened pleura covering the lung is exposed to view throughout its extent. Increased intrapulmonic pressure may or may not cause the visceral pleura slightly to approach the thoracic wall; but if it does,

the pleura immediately sinks back to its previous position. Without increasing the intrapulmonic pressure, without removal of the visceral pleura by excision (DeLorme) by corrosion (Keller) or by other methods, the lung, in perhaps the majority of cases, if the cavity is rendered sterile, will approach the thoracic wall. These observations all suggest, as Phemister has pointed out, that the important and essential factor in the obliteration of an empyemic cavity is the traction or pull of the contracting granulation tissue upon the visceral pleura at its junction with the parietal pleura; this traction or contraction continuing until the visceral and parietal pleurae come in contact with

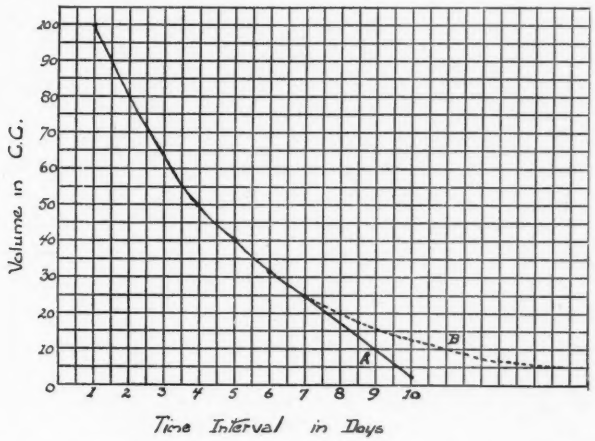

Fig. 10.—Case of postpneumonic localized empyema with obliteration of the cavity in ten days. G. V. H., Cincinnati General Hospital, Q-1833, female, aged twenty years. *A*, Curve according to actual measurements of the empyemic cavity; *B*, theoretical curve which should have been followed in the healing of this cavity.

each other and fuse. This view suggests that the healing of empyema is analogous to the healing of wounds elsewhere; that it proceeds by the development and contraction of granulation tissue; that it should be hindered or abetted by conditions which influence the healing of wounds elsewhere; and that it should conform to the laws which govern the healing of other superficial and deep wounds. Certain observations recently made by me support these statements. In a series of cases of acute empyema treated by closed aspiration drainage and irrigated every two hours with Dakin's solution, daily and very accurate measurements of the volume of the empyemic cavities have been made and charted in the form of a curve. (Figs. 8, 9, and 10.) In a fair number of cases, this curve takes the form of the curve established by Carrel and DuNoüy in healing wounds and sufficiently accurately so that the formula established by DuNoüy determining the rate of

healing may be applied to empyemic cavities. Foulger, interested with me in this work, has repeatedly predicated the date of healing of empyemic cavities from this formula and with a fair degree of accuracy. The observations are still insufficient to warrant any positive statements and will be reported subsequently. If true, they will confirm the view that empyema heals as do other wounds, for the factors concerned in healing must be the same; and will reemphasize that the general surgical principles of wound healing are of the greatest importance in the treatment of empyema.

BRONCHIAL STENOSIS*

(Concluded from p. 396)

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IV.

TREATMENT

Treatment of bronchial stenosis will vary with the underlying cause and site of the obstruction.

Treatment of tracheal stenosis and stenosis at the bifurcation should begin with bronchoscopy unless the patient is in an acute attack or there is reason to suspect a vulnerable lesion, such as aneurysm. Old stenotic scars may be gradually dilated with a bougie. Syphilitic stenosis should be treated with mercury intravenously or as a rub, and arsenicals, but not iodides. The older English authorities warn stringently against them and state that iodides cause a harmful (and if the stenosis is very narrow) occasionally a fatal increase of secretion.

Débris of an ulcerating tubercular gland may be removed through the bronchoscope by suction or with forceps; the cavity left by such a gland may be aspirated bronchoscopically. Aspiration alone may be life-saving and all that is necessary for complete relief. Mild x-ray treatment is of definite value in reducing enlarged tubercular glands. When a parenchymatous pulmonary tuberculosis complicates the glandular one dosage should be extraordinarily careful and the lung fields should be screened off, exposing the mediastinum alone. The doses need be very small; not infrequently patients with mediastinal glandular enlargements react with fever and are considerably upset by doses of 1/10 E. or less. Stenosis due to paravertebral abscesses and other posterior mediastinal collections of pus, is best attacked by draining the abscess from the rear. A tubercular spondylitic abscess may be thoroughly emptied under scrupulous asepsis, dusted with iodoform and closed without drainage.

High stenosis from aortic aneurysm is hopeless; this evidence of encroachment on the respiratory tract not infrequently forebodes fatal hemorrhage. However Sauerbruch[65] mentions several patients relieved by decompressive mediastinotomy who survived operation a number of months. The patient reported in Case 15 has survived months. Mediastinotomy comes into question when dyspnea and other signs of mediastinal compression stand in the foreground of aneurysmal symptoms.

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Read before the Thirteenth Annual Meeting of the American Association for Thoracic Surgery, Philadelphia, May 19, 1930.

Skin incision follows the midline from the cricoid to the third or fourth rib then swerves to the right for about two inches. The suprasternal notch is entered with the left forefinger which carefully pushes the mediastinal structures from the posterior aspect of the sternum; similarly the third intercostal space is entered with the right forefinger. The internal mammary vessels are tied and the pleura carefully guarded. These two fingers work toward each other. Under their protection the sternum is severed with a Gigli saw, a sternal shears, or Lebsche's sternal chisel. A centimeter or so is removed from the edges of the section and the posterior sternal periosteum is severed. If several centimeters of the first, second and third costal cartilages are removed subperiosteally before the sternum is sectioned, access from the side is easy, exposure is better and sufficiently large pieces of the sternum may be removed with a biting or cutting forceps. The opening is considerably larger than with simple sternal section. After accurate hemostasis skin and soft parts are closed without drainage. The risk of upper mediastinotomy is slight. Milton's[66] complete longitudinal mediastinotomy is more dangerous and unnecessary.

Stenosis of the upper left lobe from aneurysm of the descending aorta is not of such immediately dire import. It is doubtful whether anterior mediastinotomy will decompress the posterior mediastinum sufficiently to relieve symptoms; the stenotic upper lobe may be drained, however, in a manner to be described later. Aneurysm of the anonyma may be cured by ligation of the vessel.

Stenosis from intrathoracic goiter, dermoids or other removable growths should be attacked by removing the growth.

Large soft mediastinal tumors, lymphosarcomas or the lymphoblastomas of Hodgkin's disease produce stenotic symptoms late in spite of their size. They usually compress the veins first; early respiratory embarrassment is likely to be due to intense venous engorgement and circulatory failure rather than stenosis of the trachea or bronchial tree; more will be accomplished in emergencies caused by this kind of growth by bleeding, morphine and other measures directed toward reducing the engorgement than by attempting to dilate the trachea or bronchi. The sovereign remedy for these growths is the x-ray. They yield so uniformly and readily that one is inclined to doubt the diagnosis if they do resist. Sauerbruch recommends mediastinotomy and states that it may not only relieve symptoms but make radiation more effective. This may be true in isolated instances when dyspnea and tracheal compression stand in the foreground. Ordinarily, however, when tumor masses completely surround the trachea, bronchi and great vessels it is difficult to understand how mediastinotomy can bring about decompression. The tumor mass may expand peripherally, but its central pressure will still be unrelieved. Of three decompressive mediastinotomies done by König[67] for tumor, two died following

operation; one was relieved for six weeks and died four months after operation. I can find no records of really encouraging results.

Milton's complete longitudinal mediastinotomy done by halving the sternum is a severe operation. The two halves of the sternum slip back and forth with respiration, the chest has no hold and breathing is greatly interfered with.

Pressure from large glandular masses, tumors or abscesses may be relieved by opening the mediastinum and removing the growth or draining the abscess. An angular incision parallels the clavicle and turns downward along the sternal border, usually the right one. The sternal part of the first three ribs and the adjoining sternum are resected. The pleura is carefully pushed away and kept intact. Access to the deeper structures is surprisingly good. It may be improved further by separating the sternoclavicular joint and retracting the

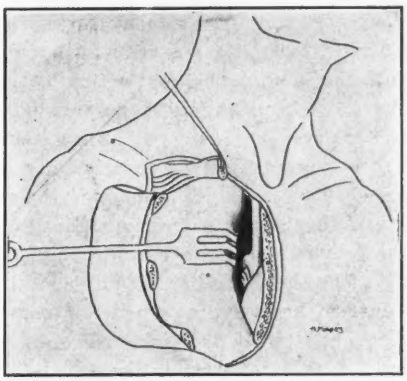

Fig. 54.—Upper longitudinal mediastinotomy, modified, after Sauerbruch.

clavicle outward. The internal mammary vessels and their intercostal communications need tying, often also the azygos vein, if the deeper structures on the right side are to be approached. A cold abscess with an intercostal fistula occasionally leads the way. If not, the large glandular masses may readily be felt in the soft mediastinal tissues, once the mediastinum is exposed. They are readily peeled out with the finger and removed. Bleeding is inconsiderable. Cold abscesses are emptied and dusted with iodoform powder but not drained. If the wound bed oozes, iodoform gauze is lightly packed into it and closure is deferred or omitted altogether. The procedure is not nearly so formidable or dangerous as it sounds. Betke[26] in an excellent paper from the clinic of Rehn Sr. describes the operation in detail. Time should be taken for ligation of all visible vessels, especially the veins, which are likely to be much engorged in cyanotic and dyspneic patients. Danger of air embolism is very real. The operation may be

conducted largely under local anesthesia. Luminal and preliminary injection of morphine together with the cyanosis that indicates intervention usually make inhalation anesthesia superfluous.

Low bronchostomy by a similar anterior mediasinal route might also be employed in cases of impermeable stricture low in the trachea or at the bifurcation. A breathing cannula might be inserted into the deeper air passages of patients who cannot be bronchoscoped and in whom a deep cannula cannot be inserted from above. Access is difficult and unsatisfactory; although such operations have been recommended they seem rarely to have been carried out. Another warning against ordinary tracheotomy may not be amiss. In low stenosis the operation is of course worse than useless. A deep Koenig's cannula may reach through the stricture but to try to insert it is prodding about in the dark. Bronchoscopy is simpler and more accurate.

Gluck[68] recommended low bronchostomy for stenosis. His plan was to make a sufficient posterior approach by resecting portions of the fifth to the eighth ribs through a posterior U-shaped incision with a lateral base, to push the pleura aside and enter the posterior mediastinum extrapleurally. The bronchus lies at a depth of about 7 cm. from the surface. It is exposed and opened, letting the patient breathe through the bronchostomy opening. A priori the operation is feasible. Patients with large bronchial fistulas can close their nose and mouth and breathe through the fistula perfectly well. Such an operation, however, taxes the patient's strength considerably, posterior access is poor and the fistula must be difficult to keep open. It is not apparent from Gluck's paper that he ever performed the operation in vivo.

Entering the bronchus under the guidance of a bronchoscope has been recommended. A tube is inserted through the bronchoscope and pushed forward toward the chest incision. The lung is incised over the tube which is pulled out into the wound.

A warm, dry equable climate without wind or dust, and a low altitude, not over 1,000-2,000 feet; rest, avoidance of physical and mental exertion, codeine, and morphine when necessary to stop cough, counter-irritants to the chest; in cases of extreme cyanosis depletion by bleeding, may be of use in high stenoses by whatever cause produced. In acute exacerbations morphine, atropine and rest together with administration of oxygen by nasal catheter should be tried. An adrenalin or ephedrin spray may help reduce swelling of the bronchial mucosa.

Treatment of *unilateral stenosis* involving one major bronchus alone will vary from the above, for the indications in unilateral stenosis are not so vital or so acute.

Again the cause should be treated; luetic strictures are rare at this level, tubercular ones from enlarged hilum glands and old deforming fibrous scars are more frequent; tumors are rare, except those so large

that encroachment on the hilum makes them inoperable. Occasionally a bronchial carcinoma projects so far from the bronchus where it originates that it occludes an entire major bronchus; such a one may still be operable.

Unilateral obstruction is most commonly caused by tubercular strictures, due to shrinking or ulcerating lymph glands and chronic nontubercular inflammatory processes (bronchitis deformans).

Bronchoscopy repeated at weekly intervals with passage of dilating instruments is a wearisome and unpleasant procedure, but it often affords great relief. In more acute cases the obstructing mass, usually an ulcerating gland may be seen and removed with the bronchoscopic forceps or by aspiration, accomplishing complete cure. Hemoptysis will make the operator proceed very cautiously. To attempt to empty the stenotic lobe by placing the patient on the bad side in the hope of accomplishing postural drainage is bad. It is the surest way of provoking a suffocative attack. The increased cough and dyspnea are harmful while the stenosis prevents effective drainage. On the other hand, putting the *bad* side at rest by placing the patient on it will often tide over an acute exacerbation and diminish fever and sepsis sufficiently to make more efficient operative methods of drainage feasible.

Carcinomas visible through the bronchoscope are usually hopeless when they lie at the hilum; they almost never arise here; their visualization at this level means that they have so far encroached upon the hilum as to be unremovable. Conceivably one might implant radium into them through the bronchoscope—a measure that would seem to offer some hope of occasional success, for the tumors themselves belong to a category of squamous cell carcinoma which in other parts of the body is not unamenable to radiation. Uncontrollable hemorrhage would be a danger to be considered; in a certainly fatal growth, however, such a risk might be taken into the bargain.

If the obstructing mass is presumably benign, if the bronchoscope demonstrates an intact nonulcerated mucosa, and if the x-ray fails to demonstrate large shadows or distant metastases then removal should be considered. A small tumor may be removed or destroyed by electrocoagulation through the bronchoscope.

Access by external operation is more difficult than in bilateral stenosis. The trachea and bifurcation may be reached through the mediastinum without much difficulty, but masses lying at or near the root of the lung are no longer accessible via this route. The pleura must be opened and the hilum examined. If the mass lies extrabronchially and is not too deeply buried in the lung parenchyma removal may be feasible although anything but easy. The pleural reflection at the mediastinovisceral junction is entered and the obstructing mass turned out with the finger. The procedure is dangerous and difficult. The

region liés deep, access is poor at best, hemorrhage difficult to control. Adhesions to the veins are especially dangerous. However, glands, cysts, and sometimes tumors, may be large enough and well enough encapsulated to make intracapsular removal feasible. If they prove inextirpable then the operation which now amounts to a simple thoractomy will do no harm. The lung will be left collapsed and the chest closed around the pneumothorax.

This leads to the second therapeutic possibility, one which is being practiced de facto, though unwittingly for bronchial stenosis very often indeed; viz., artificial pneumothorax. Artificial pneumothorax although it seldom influences the stenosis directly may help it. It will let the deviated mediastinum return to the midline; if stenosis is caused by a tracheal kink or bronchial distortion as in deforming bronchitis it may immediately straighten it. Even in stenosis caused by glandular pressure release of tension by artificial pneumothorax may straighten the veins and relieve congestion; it may, by placing the affected side at rest, help the glands to subside. Pneumothorax is also likely to stop mediastinal irritation and therewith the harassing paroxysms of cough, a benefit inestimable not only symptomatically but curatively, for nothing so much tends to keep up irritation as the very cough produced by it.

If pneumothorax is unattainable, phrenic nerve avulsion and thoracoplasty directed toward the same effect are to be thought of. One will be less ready to proceed to thoracoplasty (although this operation like artificial pneumothorax has often been done unwittingly and with good results for stenosis), for there is always risk of further increasing the stenosis and bottling up purulent secretions behind it when the lung is collapsed. After thoracoplasty the damage from collapse is irreparable. It seems quite likely that some of the lungs that do break down rapidly after thoracoplasty are stenotic, and that closure of the stenosis causes the fever and toxicity which occasionally follow operation in patients who were holding their own before. This risk is especially imminent in febrile tuberculosis. It may not be too much to ask, therefore, that tubercular patients suspicious of bronchial stenosis be bronchoscoped before thoracoplasty is decided upon, and that danger of occluding a stenotic bronchus be taken into consideration.

Stenosis involving the bronchus to a single lobe or one of its branches can be attacked more directly. Here again the cause is to be considered. Foremost, are foreign bodies, next if they can be excluded, bronchial carcinomas and other tumors. In stenosis involving a lower or middle lobe the bronchoscope and the x-ray usually give the necessary information; the cause of upper lobe stenosis will often remain obscure.

Foreign bodies large enough to obstruct one of the larger bronchi

can usually be extracted with a bronchoscope, occasionally not. If the body cannot be reached a pneumothorax will help bring it nearer the bronchoscope if not actually bring about its expulsion. Bronchoscopy after induction of artificial pneumothorax is therefore worth trying before extracting the body via pneumotomy, especially if complicated by a purulent bronchitis or abscess with the attending possibility of pleural infection.

When a tumor is seen through the bronchoscope, its location, its distance from the bifurcation, and from the bronchial mouth and, if possible, its size should be carefully estimated and a piece removed for the microscope. A tumor lying outside the parenchymatous intralobar course of a bronchus may be reached by delivering the lobe, turning it forward and incising the bronchus. A very small tumor may be removed with the galvanocautery through this incision, the bronchus may be sutured, protected with a covering of pleura and the chest closed. This plan was evolved in reconsidering operation after lobectomy for a small left lower lobe tumor. The steps should be as follows: After preparation with luminal, morphine and atropine, the chest is opened under local anesthesia through a long intercostal incision, one or two ribs being excised, if need be. Gas is now administered if necessary, the lobe is delivered and turned forward medially; 0.5-1 c.c. of 5 per cent cocaine-adrenalin solution are injected into the bronchial lumen to stop the cough reflex and the peribronchial tissues are infiltrated with ½ per cent novocaine-adrenalin. The bronchus is opened with a longitudinal incision, the edges of which are steadied with Allis forceps or stay sutures, and the tumor is sought for in the bronchial lumen. If it *proves to be movable* it is steadied with a suction tip or grasped with a sponge holder and removed with the cautery, together with a sufficient ring of sound mucosa, its base being well seared. The bronchial lumen is closed with fine silk stitches, the suture line protected by pleura and the lung inflated. If the suture line is tight, the chest is closed; if not it is packed around with gauze, the wound in the chest approximated with a few deep stitches and dressed with a bulky dressing. If the tumor is fixed it may be assumed that it has penetrated the bronchial wall; an attempt at isolated removal would be out of place; immediate lobectomy with ligation of the bronchial vessels and fixation of the amputated bronchial stump by means of clamps left in situ and packed about with gauze would follow exploratory bronchotomy.

CASE 26.—A metal polisher of thirty-three years entered the San Francisco Hospital on November 21, 1928, complaining of pain in the left shoulder of three years' duration. He had signs of stenosis of the left lower lobe, which had been mistaken for fluid and had caused the chest to be tapped. Bronchoscopy by Dr. Fletcher demonstrated a small granulating mass in the left lower bronchus, sections

of which were diagnosed by Dr. Ophüls as carcinoma. He was operated upon on December 8, 1928, through a long, left-sided intercostal incision with excision of the sixth and seventh ribs. The left lower lobe was collapsed; the lungs and pleura were otherwise normal. No abnormal masses, indurations or glands were to be felt along the course of the lower left bronchus. A large right-angled clamp was placed across the root of the left lower lobe close to the tracheal bifurcation and the lobe removed distal to the clamp with the cautery. The pulmonary vessels were ligated. A long piece of heavy black silk was put through the cut end of the bronchus and led out of the wound. The pleural cavity and the stump of the lobe were dry. A

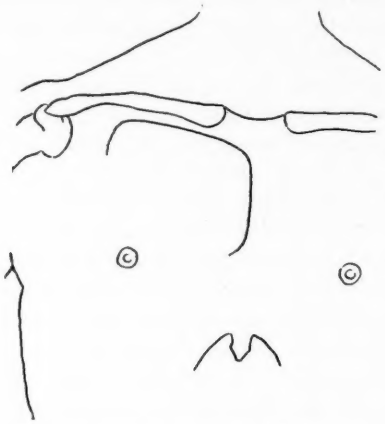

Fig. 55.—Incision for upper lobectomy.

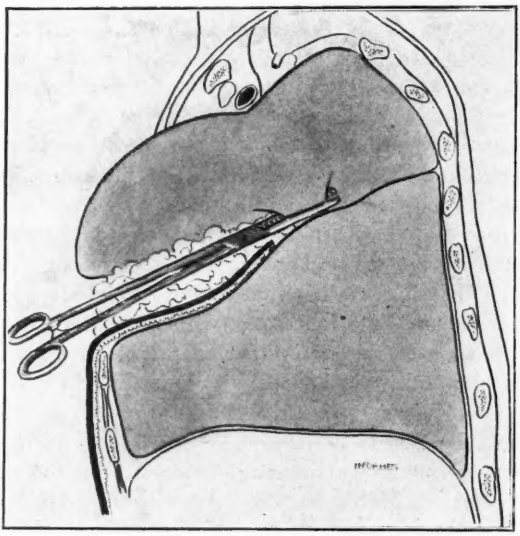

Fig. 56.—Diagrammatic cross-section of upper lobectomy. A skin flap inserted between upper and middle lobes divides the chest into two compartments.

large clamp was left on the hilum in order to fix the stump, the clamp was packed about with gauze and the wound closed. The packing and the clamp were removed five days later and the wound repacked. The patient died December 19, eleven days after operation, from a sudden violent hemorrhage from the stump of the pulmonary artery. Autopsy was refused.

Examination of the movable carcinoma mentioned above, no larger than a navy bean, leads me to believe that bronchotomy may be feasible in early cases. Unfortunately this idea came too late to admit of its being carried out and it may be years before another tumor so suitable presents itself. I should like others to try it. Tumors seem to be growing more and more frequent and, thanks to the bronchoscopists, are earlier in coming to our attention. Bronchial tumors seem not unlike tumors of the larynx; they seem to grow slowly, to be fairly

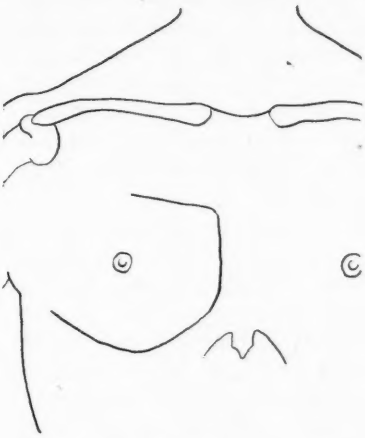

Fig. 57.—Incision for middle lobectomy.

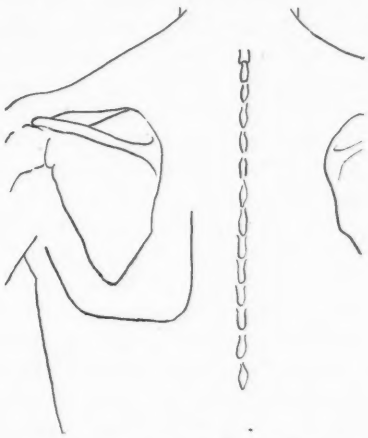

Fig. 58.—Incision for lower lobectomy.

slow in breaking through the tough bronchial mucosa and to metastasize late; bronchotomy like laryngotomy may therefore be justifiable and not too dangerous a procedure for an early cancer which has not yet pervaded the bronchial submucosa.

When the tumor lies in the intraparenchymal course of the bronchus, as most of them do, then the plan outlined above is impracticable. The chest should be opened and lobectomy carried out.

The skin incision for *lobectomy* is planned to give a flap which later is used to divide the chest into two compartments. Incision for the upper lobe is roughly omega-shaped; it begins about one inch below and a little distal to the middle of the clavicle, runs up to the clavicular edge, parallels the clavicle to the sternal border, follows the sternum to the fourth rib or the fourth intercostal space and then curves laterally again for one or one and a half inches. The flap con-

tains the subcutis and a few distal pectoral fibers. The lower fibers of both pectorals are severed about one-half inch distal to their insertion on the ribs and sternum, and about 2½ to 3 inches of the second, third and fourth ribs are resected. After clamps are placed on the hilum of the upper lobe, the flap is turned into the chest below the clamps; it separates the lower part of the chest from the field of operation; the middle lobe (or the left lower lobe) adheres to its under surface. There is no further trouble with the lower part of the chest. Similarly a horseshoe flap with a posterior base is formed over the middle lobe and inserted lateral to the hilum clamps between this lobe and the upper and lower lobes. Incision begins in the nipple line, follows the third intercostal space to the sternal border, runs downward to the sixth rib and then follows the sixth intercostal space backward and upward to the midaxilla. The flap for a lower lobe has an upper base and is inserted between the clamps and the upper and middle lobe on the right or between the clamps and the upper lobe on the left. Incision begins at the level of the sixth dorsal spinous process halfway between the scapula and the spine, at the outer edge of the erector spinae muscle; it runs downward to the eleventh rib, then turns sharply forward and runs horizontally to the anterior axillary line, and lastly upward to the level of the fourth rib.

After the chest is open the lobe is delivered and its vessels are ligated separately if time permits, or if not, the hilum is at least transfixed with two stout ligatures pulled tight. Ligation or transfixation should not be neglected unless preliminary ligation has been done at a previous stage. The hilum is then crushed between two well-closing right-angled clamps and the lobe removed with a large galvanocautery. The ligatures are left long, led out of the chest and packed about with gauze. The skin flap resulting from the curved incision is placed between the packing and the rest of the chest, and the wound is dressed with a voluminous dressing. The stump of the hilum should be ligated. Clamps left in situ are dangerous. Their removal is likely to be followed by delayed hemorrhage.

It may be advisable to ligate the branch of the pulmonary artery subserving the affected lobe at a preliminary operation two weeks before lobectomy.

Late tumors, especially those of the upper lobe, which have begun to infiltrate hilumward and in which stenosis has been of long standing may make lobectomy excessively difficult. The shrunken lobe is small; the atelectatic area forms a thin leathery cover around the tumor mass; adhesions between the shrunken lobe and the parietal pleura are extremely tough and vascular. Mobilization of the lobe is bloody and difficult. Once the lobe is mobilized so that it depends from the hilum alone the battle is won. Operation must proceed quickly, yet if preliminary ligation has not been done one should take time to tie

off the hilum vessels or at least transfix the hilum with secure ligatures, depending on clamps for stabilization of the bronchus, but not for hemostasis. I have lost three patients, one twenty-four hours, one eleven days and one a week after operation from hemorrhage after depending on hilum clamps. The hilum vessels are to be tied separately if time permits; if not the hilum is transfixed with two strong ligatures tightly tied, crushed through distal to the ligatures with one or two heavy right-angled clamps and removed with the galvanocautery beyond the clamps. A clamp may remain in place and be packed about carefully with gauze. Packing should be uncommonly careful and thorough. At times the sucking mechanism of the chest causes even small parietal adhesions to bleed disastrously. The flap from the skin incision is placed between the gauze packing and the rest of the chest dividing it in two compartments as described above. The patient should be carefully watched not only for bleeding but signs of bleeding. The nurse should be instructed to remember that much blood may be lost into the thorax before it begins to appear on the dressings.

Preparation for transfusion should be made before operation and a donor should be at hand for two or three days afterward. More or less effusion into the chest follows operation. The blood-stained fluid should be aspirated or expressed from the dressings and its hemoglobin content ascertained. Comparison of this percentage with the blood hemoglobin will not only give a better idea than ocular inspection whether it is blood or only blood-stained fluid that we have to deal with, but it will give a rough estimate of how much blood has been lost and how necessary is transfusion. Care should be taken to distinguish between postoperative collapse or shock and hemorrhage. Hemorrhage indicates transfusion. And although in general the maxim "Better too often than too seldom" will hold, transfusion is not to be used indiscriminately after lung operations. Dilatation of the right heart and impairment of the lesser circulation are often at fault rather than hemorrhage and then transfusion will do no good, but may add the last straw to a tottering man's load.

If clamps are left they should be removed in about five days. The dressings need much care with cautious and exact packing of the wound. A small leak from the stump often gives warning of a fatal hemorrhage a few hours later. The skin flap heals over the other lobe or lobes and at the bottom of the pit where the clamps originally lay a bronchial fistula appears. This gradually becomes smaller and may be closed later. It does not close by itself. Of late I have depended on ligatures rather than clamps.

Not only tumors and foreign bodies but other causes may block a single bronchus: glands, tubercular or inflammatory, old inflammatory shrinking processes and occasionally syphilis, and (in upper lobe

block) aortic aneurysm and mitral stenosis with left auricular enlargement,—causes in short that preclude lobectomy. If an aneurysm can be excluded bronchoscopic dilatation and drainage should be tried; if, however, the stenosis is impermeable and repeated attempts at dilatation are followed by repeated recurrences of stenotic symptoms with fever and other signs of retention of pus, then other means for drainage of the pent-up secretions come into question.

Drainage of tubercular pulmonary cavities is pernicious as a rule; it has been tried repeatedly and as often forsaken. If, however, protracted observation, the x-ray and lipiodol all assure one that cavitation exists distal to a stenosis and there are well-founded reasons for suspecting that fever and sepsis are due to pus blocked in the cavity then exception to the rule seems justifiable. A drainage operation is easier and more certain than open thoracotomy with a faltering attempt at removal of centrally located compressing glands. Nontubercular stenosis due to deforming bronchitis occurs usually in old and more or less decrepit individuals whose frailty makes an attempt at lobectomy unjustifiable. In these persons drainage operations are often entirely successful; they abolish the harrassing cough, fever and sepsis of the closed stenosis and the wretchedly foul expectoration of the partially open one. The operation is simple and the mortality not too great.

Case 27.—An Italian woman of forty-one years, referred by Dr. Ryfkogel and Dr. P. K. Brown, was first seen October 28, 1924. She had had syphilis sixteen years before and had been treated. In November, 1922, she had signs of cardiac decompensation which yielded to antisyphilitic treatment. In January, 1924, she began to cough and expectorate a stringy mucus; the sputum soon became purulent and in June, 1924, tubercle bacilli were found in it. In August, 1924, she entered St. Luke's Hospital with fever and expectoration of several ounces of yellow sputum per day. A wedge-shaped shadow surrounding a central cavity in the center of the right chest was seen in the x-ray films. Although the expiratory excursion of the right side was but little diminished this side of the chest was dull with a tympanitic note toward the axilla and the middle of the chest. The breath sounds were much diminished and the whole chest was full of squeaks and crepitations. The left side was free. There was a loud, scraping systolic murmur at the junction of the second rib and the sternum. Pneumothorax was attempted in four places without success. Thoracoplasty was thought inadvisable. She continued to have fever and much expectoration. The phrenic nerve was avulsed August 9, 1925. There was no improvement after operation.

In November of 1926 she reentered St. Luke's. Bronchoscopy by Dr. Fletcher revealed a thick, chronically inflamed tracheal and bronchial mucosa. Beginning about one inch below the bifurcation the right main bronchus was flattened posteriorly, gradually shutting off the tube which ended in a mass of granulations about the mouth of the lower right bronchus. Lipiodol was injected beyond this mass with a cannula. The x-ray taken after this bronchoscopy was reported as follows: The right lung field distal to the bronchostenosis contains a few small irregular blobs of lipiodol suggesting sacculation of the dilated bronchi.

On January 22, 1927, after more than two years of conservative treatment, it was decided to operate. The notes read:

"On account of cavity in the right lung with persistent sputum in amounts varying from 100 to 200 c.c. per day, with bronchial stenosis on the right side and, after considerable hesitation, it is decided to open the cavity. This is done because the extreme thickness of the pleura, the fibrosis of the lung, and the central location of the cavity make it seem unlikely that an extrapleural intervention would succeed in collapsing it. Therefore the 7th, 6th and 5th ribs are resected, at first between the scapula and the spine, for a distance of some three inches. There is excessive

Fig. 59 Fig. 60

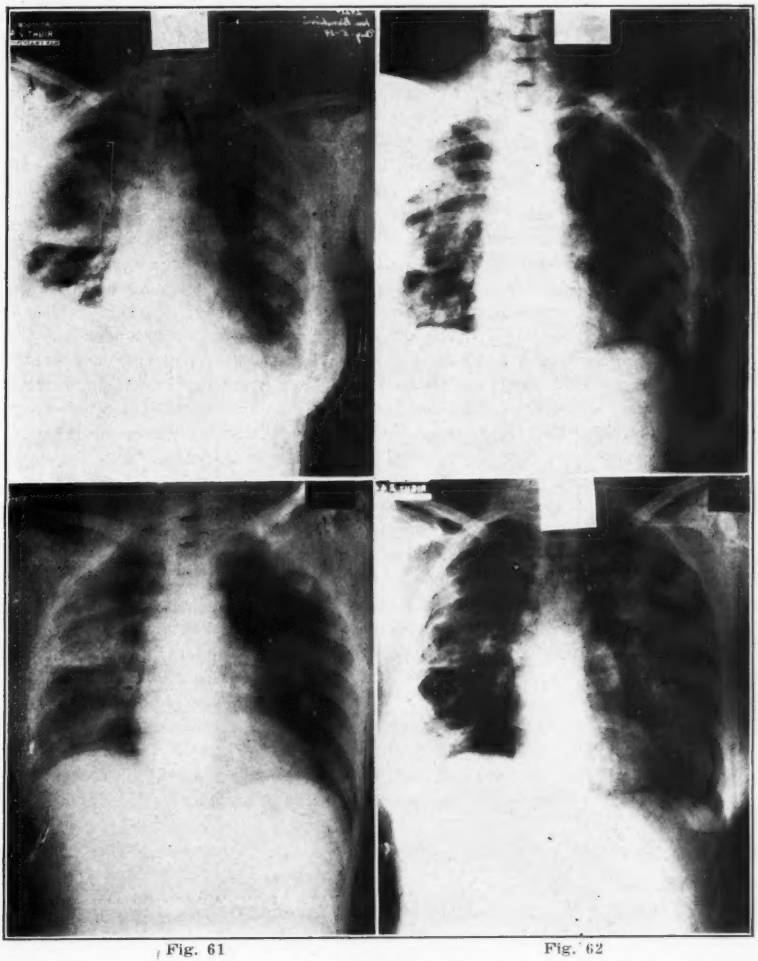

Fig. 61 Fig. 62

Fig. 59.—Case 27. Aug. 5, 1924: Infiltration of right middle lobe with central softening.
Fig. 60.—Aug. 15, 1924: A large cavity occupies the site of the right middle lobe.
Fig. 61.—Sept. 2, 1924: The whole right side is gray; the right middle lobe is shrunken.
Fig. 62.—Sept. 17, 1924: Cavity greatly decreased in size.

bleeding both in the soft parts and from the intercostal and pleural tissues. The pleura is half an inch thick and perhaps over; it is hard as bacon rind. A needle inserted at the line of the scapular angle does not reach the cavity; therefore, another three inches of the above-named ribs is taken and hereupon a needle thrust medially withdraws air. This air still comes when the needle is moved over a distance of 1 to 2 cm.; and another needle introduced at a distance of 2 cm. from the first still withdraws air, thus demonstrating that the cavity is a large one. Therefore, with a Percy cautery a funnel-shaped piece of the parietal pleura is resected in several sections making an entrance of perhaps 1½ inches across. The point of the cautery suddenly plunges into the cavity traversing multiple smaller cavities in the lung. The cavity is drained with a rubber tube and packed with iodoform gauze. The wound is left open.''

No air was expelled through the drainage opening until a week later when the patient began to blow air through the tube.

Following this drainage operation the temperature rapidly dropped to normal, the patient gained weight and strength. Cough and expectoration ceased and tubercle bacilli disappeared from the discharge. She was sent home and was able to work hard, cooking and doing the housework for a country hotel.

The drainage tube was removed and the opening closed. She had several attacks of fever and on this account was readmitted to St. Luke's where, in December of 1929, almost three years after the first operation, she was reoperated upon, an attempt being made to marsupialize the cavity. The notes read:

''This patient, who was formerly at this hospital, and operated upon for the above-named ailment, and who was sent hence home, where she made a good recovery, having gained many pounds in weight, and occupying herself in working hard at running a resort, was troubled from to time to time by rises in temperature sometimes to 104°, which would occur when the small sinus in her chest healed over. Lately, after one such rise in temperature, a catheter introduced into the chest brought forth perhaps ½ ounce of thick pus. The tube molesting the patient, it is decided to make an attempt at closing the sinus. The sinus was thought to communicate with the bronchus on the one hand and with a small localized empyema cavity (not a pneumothorax) on the other.

''Accordingly, an incision is made in the old scar. With the finger one enters the cavity, whose walls are 1 inch thick in places, and are incredibly hard. This cavity reaches up for about three ribs higher than the opening through which the tube goes. Upon widening its entrance with a galvanocautery, one sees a tiny bronchial opening with air sizzling from it. Three further ribs are resected, and the outer wall of the cavity removed with a Percy cautery. The piece removed from the outer wall measures 2½ by 3½ inches. Its lining is distinctly composed of a narrow layer of gray, pulmonary parenchyma studded with small abscesses. All of the overhanging edges of the cavity having been removed, and only its fibrous base remaining, the resulting wound is packed with iodoform gauze. No stitches are taken.''

This attempt was a mistake. The large cavity has decreased in size very slowly. It would have been better to have let the patient wear her tube indefinitely.

For drainage of a stenotic lower lobe, a hockey-stick incision is made posteriorly; an anterior or axillary incision is made for the upper lobe and a curved incision paralleling the lower mammary border for the middle lobe; three to four inches of three ribs are dissected free of their periosteum without opening the pleura. If the pleura is thick and the lung adherent, the ribs are resected and the lung immediately

entered with a Percy cautery. A large flat area is excised or charred and several cavities are opened, as in operation for bronchiectasis. If the pleura is thin, and speckled lung is seen sliding back and forth under it, it is carefully peeled away from the overlying ribs which are left in situ, a large Mikulicz tampon of gauze or a bismuth paraffin mixture is inserted between the ribs and the pleura, and the skin and soft parts are closed over it with a few deep stitches. In about two weeks the wound is reopened, the ribs are resected and the pack removed. The preliminary operation is seldom necessary, for the stenotic lobe is usually covered by a thick and adherent pleura. The lung is now adherent and may be entered with impunity. Perforation of a free pleura at the first stage should be carefully avoided. Negative intrathoracic pressure is excessive and the pneumothorax resulting from perforation delays the second stage. Should this accident happen the pack is omitted, the air aspirated and the chest closed. The wound is reopened in two or three weeks. The previous accidental pneumothorax will probably have caused adhesions; if not the wound is packed and closed a second time; it is reopened and the pack removed again after another two weeks.

It is not wise to proceed too deeply or too far when the lung is first entered with the cautery. Retraction of the stenotic lobe is astonishing; a small cavity opens into the wound at first, gradually epithelializes and increases greatly in size, revealing further cavities as it shrinks away from the surface. These cavities are easily entered with the cautery at subsequent sessions for which anesthesia is unnecessary and the original thoracotomy opening need rarely be enlarged. When the cavities are first opened pus comes from them but no air; this notable operative finding corroborates the diagnosis of stenosis. Gradually as the stenosis gives way more and more air is blown through the wound on expiration. (Cf. Case 28.)

Stenotic upper and lower lobes are easily found and entered; middle ones, especially when they lie medially next to the sternum and are covered by distended upper and lower lobes may be difficult to expose.

There is often an amazing gain in weight and strength after the stenotic lobe is opened and drained.

The bronchial fistula may remain open indefinitely. It may also, if expectoration entirely cease and the patient's condition seem to warrant, be closed by extirpating the remains of the shrunken lobe after the manner described by Lebsche[69] for "gridiron" lung. The thoracotomy opening, which is usually much shrunken, is restored to its original size by an incision through the old scar at the border of the skin and pulmonary epithelium. The remainder of the shrunken lobe is then cautiously dissected down to the hilum. Dissection is not difficult; bleeding is decreased by using the cautery instead of the knife. When the hilum is reached the bronchus is incised, but not cut across

until it is carefully secured against retraction by guy sutures. After these are placed the incision is carried through and the bronchial stump is closed with interrupted stitches of fine silk. The vessels are tied and the remains of the lobe drawn with a few stitches over the bronchial stump. The skin is closed with a drainage tube to take care of pleural secretions and pressed onto the stump of the lobe with accurately placed dressings. A rubber bath sponge held in place by adhesive or a Scultetus bandage makes a useful dressing.

Extrapleural procedures, thoracoplasty, etc., are not indicated, unless preliminary to lobectomy for tumors. Even here thoracoplasty seems scarcely necessary. Thoracoplasty, if efficient, compresses the stenosis and increases difficulty of spontaneous drainage through the bronchus.

Treatment of diffuse sclerosing processes involving the smaller bronchi and bronchioli lies beyond the province of surgery. Rest, morphine for the acute attacks, atropine, ephedrin, a low, dry, equable climate, avoidance of exertion and watchful care of the circulatory apparatus require the ministrations of a competent internist.

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BRONCHIECTASIS*

(Final Installment)

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(Concluded from page 431)

IV. TREATMENT

XIX. TREATMENT OF BRONCHIECTASIS BY PNEUMOTOMY

THE treatment of bronchiectasis by pneumotomy has been more or less discarded. It is obvious that simple incision and drainage of a dilated bronchus can hardly be expected to accomplish much in the presence of other dilated bronchi which are not reached by the incision. In fact it is now well-known that such is usually the case. Had modern methods of diagnosis been employed in some of the cases in which good results had previously been obtained we feel quite certain that the underlying lesion would have been found to be one of pulmonary abscess rather than bronchiectasis.

Garré, in 1902, reported 400 pneumotomies for various pulmonary lesions with 100 deaths, a mortality of 25 per cent. In this number were included 57 cases of bronchiectasis with 21 deaths, a mortality of 37 per cent. Sauerbruch (cited by Denk) in 1911, reported 123 pneumotomies. There were 43 deaths (35 per cent), the condition of 33 patients was uninfluenced (27 per cent), 7 were improved (6 per cent), and 40 (33 per cent) were cured. Sauerbruch reported 100 collected cases. The operative mortality was 23 per cent. There were 33 per cent cures. Batzdorff was able to collect 53 cases in 1913, with a mortality of 62 per cent and 9.4 per cent cures. Körte reported 21 cases of bronchiectasis in 1908; 15 were treated by pneumotomy, with 4 cures and 11 deaths, a mortality of 73.3 per cent. Hedblom, in 1924, referred to two cases of saccular bronchiectasis in which improvement resulted from pneumotomy. Tuffier reported 46 cases with 10 deaths, and Denk has recently reported three cases with one death from brain abscess, one moderate improvement and one definite improvement.

One can hardly expect much from pneumotomy unless when dealing with a single bronchiectatic abscess. A satisfactory result is seldom obtained because of associated bronchiectasis for which simple drainage does not suffice.

XX. TREATMENT OF BRONCHIECTASIS BY CAUTERY PNEUMECTOMY (GRAHAM)

One of us (E. A. G.) in 1923 proposed the use of the cautery as a safer substitute for the ordinary lobectomy in cases of chronic suppuration of the lung and also in those cases in which an attempt at lobectomy must be abandoned because of too extensive adhesions or for other reasons. Some time after proposing this operation in 1923, our attention

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was attracted to the fact that Sauerbruch had described, in 1920, a somewhat similar procedure which he mentions briefly in a few lines in his book. Several authors have referred to the Sauerbruch procedure and to our operation as if they were identical. But, as a matter of fact, it seems to us that there is a considerable difference, at least in theory. Sauerbruch's operation is a lobectomy performed by the cautery. Our operation, on the contrary, is based on the idea of removing only the diseased portion of the lobe, although occasionally subtotal lobectomies have been performed. We have applied this method not only to bronchiectasis with or without abscess formation, but also to chronic lung abscesses. The statistics and case reports which follow will clearly show that the method is capable of wide application and that the operative mortality associated with it is reasonably low, even in severe cases.

INDICATIONS

Bronchiectasis associated with multiple lung abscesses and chronic lung abscesses with secondary bronchiectasis are the types most suited for cautery pneumectomy. In some the abscesses seem to be primary to the bronchiectasis, and in others to have resulted from the bronchiectasis. In these cases the ordinary roentgenological picture frequently suggests chronic suppuration or new growth. Those whose dilatations present the appearance of grape or bead formation also respond in a most satisfactory manner (see previous classification for bronchographic types). These forms are in many instances consequent to the bronchopneumonias of the exanthemata, pertussis and influenza. Some striking results have been obtained too in the treatment of patients with similar lesions due to foreign bodies. The presence of an associated bronchopleural fistula or empyema does not detract from the expected result. Patients suffering from the above types of bronchiectasis are usually septic and when first observed have fever, leucocytosis, etc. In such cases thoracoplasty is frequently fatal as has been shown by Hedblom. We believe also that lobectomy will necessarily have a very high mortality in such cases. Simple drainage is generally useless because of the impossibility of draining the multiple foci of suppuration adequately. We believe, therefore, that the operation of cautery pneumectomy in this type of lesion is the most satisfactory procedure from the standpoint of both mortality and final results.

Cautery pneumectomy does not seem suitable for those cases of bronchiectasis which are perhaps of congenital origin and which are associated with long and wide dilatations in a lower lobe (saccular type). Cautery pneumectomy should be employed with caution in the presence of extensive bilateral lesions because if the opposite lung is badly diseased the patient may observe but little or no improvement regardless of the result obtained on the treated side. We have, however, employed this type of operation successfully in one case of bilateral chronic abscesses with localized bronchiectasis. The procedure has also been em-

ployed as a palliative measure in nine cases of carcinoma of the lung in which the effects of secondary infection with much sloughing of tissue were conspicuous features.

To put it more concisely one can state that cautery pneumectomy is recommended to those suffering from unilateral types of bronchiectasis who have not responded well to the simpler forms of therapy, for whom thoracoplasty is either not indicated for various reasons or has failed to relieve the symptoms, and upon whom the performance of a lobectomy, although desirable, is unwise or technically impossible.

TECHNIC

The operation of cautery pneumectomy can be made to combine the three cardinal principles of the surgical treatment of chronic pulmonary suppuration, namely, drainage, compression and extirpation. (Fig. 29.) For this reason it would seem to have a wider applicability than any other method so far proposed. Again, the fact that it can be performed in multiple stages with relatively little disturbance to the patient makes it suitable even in patients whose vitality is low.

At the first stage the field is exposed by turning up a flap of skin and muscle and the removal of two or three ribs for distances of about three or four inches (8 or 10 cm.) The ribs are removed by subperiostal resection, and the periosteum is then peeled off the pleura with the intercostal bundles, including the intercostal muscles, vessels and nerves. This procedure, in itself, permits an appreciable amount of compression of the affected lung tissue, although of course not to the same extent as in a thoracoplasty. The exposed ends of the ribs are packed with bone wax to minimize the danger of osteomyelitis. The diseased portion of the lung is now in view, covered by pleura to which it is often densely adherent. It is essential, before proceeding further, that the lung should be firmly adherent to the pleura. Otherwise, after the pleura has been penetrated, the lung will retract away, and an empyema will result. To determine definitely whether or not the lung is adherent, the pleura should be opened. If the lung is found not to be firmly adherent, adhesions can be created by any of the standard methods, such as suture and gauze packing against the pleura. If, while making the investigation, the lung has become retracted away from the pleura by an inrush of air into the pleural cavity, it will be found best then to inflate the lung by positive pressure, to close the pleura, to pack gauze against it and to postpone any further operative procedure until after the lung has become adherent. After the exposure has been made, the first stage of the operation can then be terminated, and, in patients who are bad risks, it is well not to proceed further at this stage. No sutures are placed in the flap.

After the lapse of about ten days the first cauterization can be done, or, if the patient is in good condition and if adhesions are known to be present between the lung and parietal pleura the first cauterization can be performed at the time of making the exposure. With a large soldering iron heated to a red heat an excavation is then made into the lung tissue (see Fig. 29). If an old drainage track exists it is well to begin the cauterization by plunging the hot iron into the sinus and to work out from that eccentrically. Other abscesses are sometimes found in this way lying close to but not communicating with the main drainage track. In the cases in which the pathological condition is chiefly that of a chronic abscess the whole abscess cavity, together with other smaller abscesses, may be cauterized out in this way, or at least the roofs of the abscesses should be removed. In those cases, however, in which the chief pathologic condition is bronchiectasis the first objective is to provide multiple drainage openings by exposing a large cross section of the bronchial tree. To accomplish this the effort is made to begin by burning over a

fairly large surface instead of by burning too deeply into the lung. After the slough has separated there are sometimes as many as ten or fifteen bronchial fistulas from each of which pus exudes. As a rule the better the drainage established the more rapid will be the convalescence. Repeated cauterization should not be done too soon. Our experience has shown that it is better to wait about three weeks before

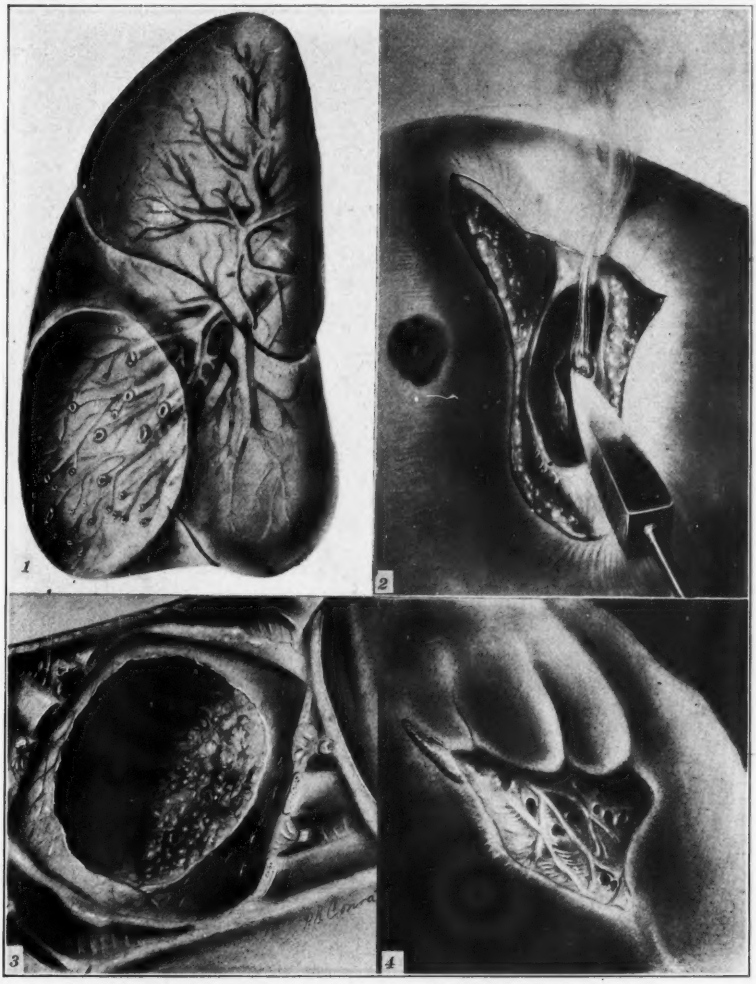

Fig. 29.—Cautery pneumectomy (Graham):

1. Diagram to show how massive drainage and gradual extirpation of the diseased portion of the lung can be accomplished. Pressure to any degree can also be exerted by a gauze pack in the wound.

2. Shows the application of the hot soldering iron after adhesions have been created.

3. Drawing made at operation immediately after first cauterization. Note particularly the large exposure and the accessibility of the cavity to packing.

4. Illustrates the massive drainage permitted by the many open bronchi which have been allowed to discharge their contents to the surface.

Fig. 30

repeating the cauterization. Indeed in some cases we have found that much less cauterization has been actually necessary than had been originally supposed if several weeks of free drainage through multiple bronchial fistulas had been permitted. There is undoubtedly some tendency in even the long standing cases for the diseased tissue to heal if given an opportunity by providing adequate drainage of the pus. This is in accord with the experiences of Willy Meyer with "lip fistula." The establishment of many bronchial fistulas by a cross section of a relatively large part of the affected lobe certainly provides better drainage than can be accomplished in any other way. Moreover, the effect of the heat from the cautery is transferred to a variable distance away from the place with which it is actually in contact and this effect doubtless leads to the destruction of more secreting surface. The question, therefore, of how much and how often to cauterize will be determined by the progress of the case after the first cauterization. In some of our cases one cauterization has been sufficient and in others three or four more have been undertaken. The best rule to follow is that it is better to do too little at a time rather than too much. If hemorrhage from a large vessel occurs it may be controlled by packing and the operation is terminated then. In such cases it is well not to remove the packing until after about a week or ten days. If, however, the pack has become loosened spontaneously it may be safely removed before that time. It should be followed, however, by the application of a fresh packing. We have not found any difficulty in controlling hemorrhage by packing even if a relatively large branch of the pulmonary artery has been severed. This is doubtless because the blood pressure in the pulmonary artery is only about one-sixth of that in the systemic circulation. The control of hemorrhage is much easier if the exposure is generous. It is unwise and dangerous to attempt an extensive cauterization through a small opening. Moreover, by working in a small opening one of the main purposes is defeated, namely, the creation of very free drainage by making a large cross section of lung surface and thus permitting drainage from many open bronchioles. After the operation there is no specimen to show as only charred fragments are removed. It has seemed wiser to us to control hemorrhage by packing rather than by attempting to pick up and ligate the bleeding points since if the latter procedure is used it is often difficult to find the bleeding vessels because of the gush of blood. Much blood may, therefore, be lost while one is attempting to find the bleeding vessels, and other portions of lung tissue may be torn during the process of clamping them.

Certain important effects of the cauterization are usually observed. While the cautery is actually in contact with the lung there is frequently a period of apnea which may last for about thirty seconds even after it has been removed. Smoke may be exhaled from the nose and the mouth and if hemorrhage has occurred there may be some bloody expectoration. Usually there is no shock and the patients look as though no operation had been performed on them. For the first 24 or 48 hours there may be either a marked diminution or a complete absence of cough or sputum. The explanation of this phenomenon is not entirely clear. It may be due to a temporary abolition of the cough reflex. Generally on about the third day the patient develops a little fever and complains of malaise, loss of appetite and even sometimes of nausea and vomiting. These symptoms are apparently due to intoxication from the

Fig. 30.—*1.* Notes the type of lesion present in a patient whose original condition was apparently chiefly one of multiple abscesses in the right upper lobe (10-29-29). The two arrows indicate abscess cavities. About two years after recovery from this lesion as a result of a cautery pneumectomy, the patient returned with symptoms and easily demonstrable bronchiectasis involving the rest of the lung (Fig. 2, 7-31-31). There is, of course, a possibility that the patient's original condition was chiefly one of bronchiectasis and that a superimposed infection at first limited to the upper lobe later extended to the lower lobe making the dry dilatations "wet."

Fig. *3* (3-15-28) refers to the type of bronchiectasis present in the patient considered in Case 15; and Fig. *4*, shows the ring-like shadows typical of bronchiectasis which were present in another patient who was successfully treated by cautery pneumectomy.

burnt tissue and they furnish another reason for not performing too extensive a cauterization at one stage. These symptoms of intoxication are likely to persist until the slough has separated, usually about the tenth or twelfth day. Coincidently with the appearance of these symptoms the cough and sputum may be increased and may actually become greater than before the operation. Later as the slough separates and as the open bronchioles begin to discharge pus to the outside the cough and sputum diminish, the fever disappears, the appetite returns and the patient feels well.

The danger of severe postoperative hemorrhage after the slough has separated is a question that has been raised by some surgeons. The danger doubtless exists but in our experience it is nearly negligible. A wise precaution is to keep a large roll of gauze for packing present in the patient's room for a week or ten days after the separation of the slough so that it can be used immediately if a severe hemorrhage should occur. Doubtless postoperative hemorrhage might occur from the bronchial arteries instead of from the pulmonary arteries. If hemorrhage should occur from the bronchial arteries it might be a little harder to control by packing because these vessels are connected with the systemic circulation and, therefore, have the systemic blood pressure. It is also true that in advanced cases of bronchiectasis the bronchial artery may be considerably enlarged. However, the fact remains that in our experience postoperative hemorrhage does not constitute a serious danger.

A greater danger than hemorrhage exists in the possibility of cerebral embolism. In two cases during the actual cauterization death has occurred on the operating table preceded by signs of cortical irritation. It seemed probable that these deaths were due to cerebral embolism, possibly of air. Perhaps the occurrence of embolism could be averted if one should ligate the pulmonary vein as a preliminary measure. We have not, however, carried out this procedure.

The operation has been used upon patients of widely different ages, namely, from two years to sixty-one years respectively. It is, of course, important to avoid any inflammable gases for anesthesia. Our own preference is nitrous oxide. The actual cauterization can often be performed without any anesthetic because the lung is insensitive to pain. Most patients, however, dislike the inspiration of smoke from the burning tissues which is inhaled through the open bronchi and comes up into the mouth and nose. This objection is one of the principal reasons for using nitrous oxide. It is also desirable that the operation should be a short one lasting for only a few minutes. In our own cases the cauterization seldom requires more than ten minutes and usually less.

RESULTS

The results of cauterization in twenty cases of chronic lung suppuration were published by Graham in 1925. Six patients (30 per cent) were free from symptoms and completely healed, six patients (30 per cent) were free from symptoms but had bronchial fistulas. Three patients (15 per cent) showed marked improvement. In two the improvement was still in progress, and one patient was lost track of. There were four deaths (20 per cent).

If one compares these results with later ones published in 1929, on 54 cases, then one must be impressed with the low operative mortality in a large series of cases and with the excellent late results. (Table VIII.) Although 12 additional patients have been operated on since 1929, making a total of 66 cases, we feel that these later operations have been too recent to afford an adequate opinion of the late results. They are therefore not included in the table.

TABLE VIII

RESULTS OF OPERATIONS OF CAUTERY PNEUMECTOMY PERFORMED PRIOR TO 1930, NOT INCLUDING CARCINOMA OF LUNG

Number of Cases	54	
Definitely Improved	36 (66.6 per cent)	
Moderately Improved	2 (3.6 per cent)	
Slightly Improved	3 (5.6 per cent)	
Not Improved	7 (12.6 per cent)	
Dead (Operative Mortality)	6 (11 per cent)	
Late Results		
Number of Cases	54	
Number of Patients Still Alive	36 (66.6 per cent)	All Patients at Work
Definitely Improved	34 (63 per cent)	
Moderately Improved	1 (1.6 per cent)	
Slightly Improved	0	
Not Improved	1 (1.6 per cent)	
Operative Deaths	6 (11 per cent)	
Late Deaths Not Due to Operation	12 (22 per cent)	
*Bronchial Fistula Still Present	17 (47 per cent of living patients)	

* In 3 of the 17 patients with fistulas reported, closure is known to have occurred subsequently since the publication of the above table in 1929 (Arch. Surg. 19: 1569, 1929). And in 2 others, information has reached us that the fistulas are closed. At the present time, therefore, open fistulas remain in only 12 patients (33 per cent of the living patients). Some of these 12 patients have declined any operative attempts at closure, because the inconvenience of the fistula to them is slight.

In the above table the expression "definitely improved" signifies that the patients so designated have been able to return to their normal activities and that they are free from all symptoms except that in those noted a bronchial fistula remains. We have thought that there were advantages in using the expression "definitely improved" rather than "cured."

A presentation of some personal experience with cautery pneumectomy now follows:

CASE 12.—Cautery pneumectomy for multiple chronic abscesses of the lung and bronchiectasis.

Result: Clinically well.

D. B., (Fig. 31, No. 1) a colored boy, five years old, was admitted to St. Louis Children's Hospital on September 6, 1923, complaining of severe cough and copious foul expectoration. In August, 1922, he contracted a right sided pneumonia. A thoracostomy for empyema was performed at the City Hospital in September, 1922. The cavity was drained for seven weeks and then apparently healed. In March, 1923, the patient had an attack of measles which was followed by a persistent fever. Shortly after this an abscess situated in the region of the right scapula was said to have ruptured into the lung and the patient began to be troubled with cough and foul expectoration.

On admission the physical signs combined with roentgen ray and fluoroscopic observations localized the lesion to the right lung. The lesion extended downward both anteriorly and posteriorly from the fourth rib.

A cautery pneumectomy was performed (E. A. G.) on September 8, 1923, with the patient under nitrous oxide anesthesia. The pleura was found to be adherent. The right lower lobe was indurated and nodular. Almost the entire lower lobe was burned out with the cautery. Six different abscess cavities were cauterized. The postoperative course was uneventful.

One month following operation the patient developed a bronchopneumonia which ran the usual course and from which he completely recovered. He was discharged on December 23, 1923. The wound was entirely healed except for the presence of several bronchial fistulas. These were closed by an extensive plastic operation which

was performed in three stages. The first operation was carried out on May 25, 1928, in the following manner: "Usual incision close to the spine on the right side, subperiosteal resection of fifth, fourth, third, second and first ribs. The fifth rib was removed from the transverse process to a point close to the old cavity. Corresponding sections of rib were removed from others. About one inch of the first rib was removed. Closure in layers without drainage." The second stage of the thoracoplasty was performed on June 2, 1928. The lower ribs were then removed right up to the cavity. After removing these ribs, the cavity collapsed and came together in a very satisfactory manner. The final operation was performed on June 14, 1928, in the following manner: "Two ribs at angle of cavity removed. A bony wall anterior to the cavity was also removed. The lung was mobilized by cutting it from the chest wall. The mobilized lung was then turned into itself in a manner which completely obliterated all of the cavity. Two layers of lung tissue were sutured over to each other. The skin which had formed extensively over it and which was loose after the removal of ribs anteriorly was sutured together with three silk worm sutures. There was no tension on any of the sutures. A roll of gauze was packed tightly outside the skin in order to form a firm buttress against coughing." The patient is now entirely free from symptoms, his wound is solidly healed.

CASE 13.—Cautery pneumectomy for abscess of the lung and bronchiectasis.

Result: Patient well and free from complaints eight years after his operation.

E. H. (Fig. 31, No. 2), a white man, aged forty, was admitted to the medical service of Barnes Hospital on July 25, 1923. He then stated that his complaints of cough and expectoration were of many years' duration. He coughed continuously raising foul yellow sputum. His condition had been diagnosed pulmonary tuberculosis and he had been treated with "serum" and heliotherapy. Later he was told that he had pneumonia with abscess formation. After seven weeks in bed during the latter part of 1922 he was able to go back to work; but his cough persisted.

Physical examination on July 25, 1923: The patient was fairly well nourished. The percussion note was impaired below the angle of the scapula on the left side. Breath sounds were impaired at the left base and crepitant râles were present. Roentgen ray examination showed an increase of hilus shadow and a thickening of the lung markings in association with fine parenchymatous mottling on the right side. Confluent with the hilus shadow on the left was an irregular wedge-shaped dense patch extending across the lateral chest wall. Within this area were indefinite dark areas suggestive of cavities. This patient was examined before the use of lipiodol was introduced. The blood Wassermann reaction was negative. The tuberculin complement fixation test was negative. The sputum culture yielded streptococcus viridans. The dark field examination of the sputum was negative. No elastic tissue or acid fast organisms were found. His leucocyte count was 14,000; hemoglobin 85 per cent. The urine contained a faint trace of albumen. The temperature rose to 38.5° C. each evening.

With the patient under nitrous oxide ether anesthesia, on July 30, 1923, the seventh and eight left ribs were resected for a distance of about four inches. Intercostal bundles were excised (E. A. G.). Intercostal nerves were injected with 95 per cent alcohol. We no longer inject the intercostal nerves with alcohol in such cases because we have had several instances of troublesome neuritis after this procedure. The pleura was not adherent to the lung, so it was not opened, but iodoform gauze was packed against it to produce adhesions. The wound was left open. One week later the second stage of the operation was performed. The pleura was greatly thickened and the lung was firmly adherent to the parietal pleura. Pus was not found with an aspirating needle, even when one of very large caliber was used. The cautery was plunged into the indurated portion of the lung and a cavity containing about 10 c.c. of very thick pus was found at a distance of about 2 cm. from the

Fig. 31.—Cautery pneumectomy for bronchiectasis and for abscess of the lung plus bronchiectasis:

Patients referred to in Cases 12 (No. *1*), 13 (No. *2*), 14 (No. *3*), and 16 (No. *6*). The clinical records of the patients referred to in Fig. 31 (*4* and *5*) have not been recorded. The patient in Fig. 31 (*4*) was operated on in 1929, for disease of the upper lobe and when last seen was solidly healed. However, he still has some bronchiectasis in the lower lobe (See Fig. 30 (*1* and *2*), which is accompanied by so few symptoms that surgical interference seems not to be indicated at present. The patient in Fig. 31 (*5*) was operated on in 1924 and is alive and well.

lung's periphery. The roof of the abscess was burned away. There was no hemorrhage. The cavity was lightly packed with gauze.

Following the operation the patient improved rapidly. The cough became less; the drainage rapidly decreased, and the bronchial fistulas closed. He was discharged on August 26, 1923. One month later fluoroscopy showed a faint shadow in the left axillary line which was thought to be thickened pleura. The patient has remained entirely well since that time; he weighs more than ever before, and has no cough or sputum. He is steadily at work as an engineer.

CASE 14.—Cautery pneumectomy for bronchiectasis.

Result after seven years: Patient active, well, bronchial fistula still present.

T. T. (Fig. 31, No. 3), a white man, aged twenty-four, entered Barnes Hospital on January 3, 1924, complaining of "cough and weakness." His family history was negative. He had had pneumonia when seven years of age. He was then in good health until five years later (1911) when he fell off a bicycle. This caused him to raise two mouthfuls of thick yellow material. There was no cough or discomfort until one year later (1912) when he became suddenly ill with chills and headache at which time he coughed up a cupful of thin yellowish material. However, he soon felt better and gained weight. Three years later (1915) he began to suffer from loss of weight and weakness, and began to cough up considerable sputum on retiring, never in the morning. At this time he went to the Pacific coast where he gained weight and stopped coughing. In 1917 he caught a bad cold and began coughing in the mornings. About two months later he raised a large amount of sputum, and from that time on had a productive cough. His condition was diagnosed as pulmonary tuberculosis. Beginning in February, 1922, the patient stayed in bed for seventeen months on the advice of a physician. In July, 1923, his condition was diagnosed as lung abscess, and on July 28, 1923, portions of three ribs were removed and the lung was cauterized and drained elsewhere. After a stormy postoperative course the patient gained weight and his cough decreased. Three weeks after the operation the patient had a pulmonary hemorrhage. Following the healing of the chest wound the patient coughed considerably and raised about three cupfuls of sputum daily.

Physical Examination: (January 3, 1924) The young man was emaciated. His mucous membranes were pale. Over the region of the right base of the lung, posteriorly, there was an old operative scar and local collapse of the chest wall. The percussion note was resonant everywhere except over the right base where it was dull from the angle of the scapula downward. Over this region the breath sounds were of the bronchial type and whispered sounds were increased. Râles were heard in both bases. A culture of his sputum showed streptococcus viridans. An examination of the sputum for spirochetes and acid fast bacilli was negative; the blood Wassermann reaction was negative; the urine examination likewise. The phenolsulphonephthalein kidney function test totaled 50 per cent in two hours. There was no anemia. The roentgen ray examination showed that segments of the ninth, tenth and eleventh ribs on the right side had been resected posteriorly. There was a large area of density of the lungs confluent with that of the heart below this point. There was a slight increase of the hilus shadow with fairly extensive thickening of the lung markings. The patient did not have fever. From the findings it was concluded that he was suffering from a bronchiectasis of the right lower lobe with abscess formation.

Under local anesthesia an incision was made through the old scar on January 12, 1924. Two of the regenerated ribs were removed. The lung was firmly adherent to the chest wall. A large cup-shaped area was burned out of the lung with the cautery. Several pockets of pus were entered and drained. A small hemorrhage occurred. It was easily controlled by packing. When the packing was removed three days later the patient lost about 200 c.c. of blood from an intercostal artery, without ill effect. Nine days later as a preparation for further operative procedures the patient was transfused with 500 c.c. of blood. On January 29, 1924, more lung tissue was burned away with a cautery. The cautery was passed upward close to the spine and entered a fairly large bronchiectatic cavity containing thick pus. On February 21, the old incision was opened and a considerable amount of pus-containing lung tissue and greatly thickened and enlarged bronchi were treated with the cautery. As the wound began to close the patient coughed more. On April 30 the wound was

reopened to permit freer drainage. No cauterization was done. The patient left the hospital on May 14, 1924. He was observed again on June 25, 1924, when he was allowed to return to his home in New Mexico. A letter from the patient on July 15, 1924, stated that he continued to cough some, had some drainage from the sinus in his chest but that he had gained weight and strength. He was able to drive an automobile and to go fishing and hunting. This was rather gratifying because he was practically bedridden for the two years before his admission.

The patient returned for observation in September of the same year. He stated that he considered himself practically well. He had gained 22 pounds (10 kg.), and was able to do anything he wished without abnormal fatigue. His wound had three unhealed bronchial fistulas from which a small amount of mucopus was discharging. He coughed occasionally; his expectoration never exceeded 50 c.c. of sputum in 24 hours and probably came from an involvement of the middle lobe which had not been operated upon. He was sent home again for a period of a year to decide whether more cauterization would be necessary. Up to the present time this has not been considered advisable or necessary. The patient caught a severe cold in June, 1930, and discharged large quantities of pus from the bronchial fistula which still remained. He also had profuse expectoration. This attack cleared up in three weeks. His cough and expectoration are now less than they have been for years. Since his operation this patient has been able to mingle freely in society and plays in an orchestra and does broadcasting. He has married since his operation, and runs a fruit ranch in California.

CASE 15.—Cautery pneumectomy for bronchiectasis, the result of a war wound.

Result: Returned to work, with marked improvement in symptoms.

F. L., man, aged thirty-three, was first admitted to Barnes Hospital on June 5, 1929, complaining of hemoptysis, cough and purulent expectoration. This patient was shot through the right chest in September, 1918, while at the Front, and was picked up by members of the German army and taken to one of their hospitals. About five days after the injury a rib resection was done and the wound healed completely in four months. The patient was then discharged.

Just what his complaints were previous to the rib resection is difficult to ascertain. Following his discharge from the army sometime later and after working for six weeks, he began to cough and expectorate blood streaked sputum. This was shortly followed by the expectoration of a piece of bone. He was then admitted to the United States Government Marine Hospital for three months. A productive cough persisted and he also had hemoptysis from the lung. He entered the Walter Reed Hospital in May, 1924 where a thoracostomy was done. At this time he had a hemorrhage through a bronchial fistula. He was discharged in six months as well, but six weeks after his discharge expectorated a large quantity of blood streaked pus. This complaint persisted up to the time of his admission to Barnes Hospital.

This case has been included here because it represents one of those obstinate types of bronchiectasis, multiple in origin and undoubtedly due to the presence of many spicules of bone throughout the lung; all the result of the war injury. Bronchiectasis in such a case is produced in a manner similar to that produced by bronchial stones or foreign bodies.

A lipiodol injection performed at Barnes Hospital revealed the presence of many bronchiectatic cavities with fluid levels. (Fig. 30.) A bronchoscopy by Dr. Arbuckle on June 12, 1929, suggested the presence of a cavity leading off from the lower portion of the right main bronchus. A cautery pneumectomy was performed on July 6, 1929. The lung was found adherent and several pockets of pus were treated with the actual cautery. The postoperative course was uneventful. The patient was discharged on August 16, 1929. Bronchial fistulas were still present and have been allowed to persist even though the patient is relatively free from cough and expectora-

tion; a lipiodol injection on September 7, 1929, failed to show any obvious bronchial dilatations. A subsequent injection on October 13, 1930, showed the presence of one dilatation, and the patient occasionally has the sensation as if a spicule of bone is trying to make its way up into his trachea. Since his discharge from the hospital he has been able to earn his living as a salesman.

It is too early to prognosticate the end result in this case, and it has not been included in the table. (Fig. 31.)

CONCERNING BRONCHIAL FISTULAS AFTER CAUTERY PNEUMECTOMY

Bronchial fistulas, the result of cautery pneumectomy, are never allowed to close before one is quite certain that the diseased bronchi and lung tissue have been adequately treated. They are, therefore, seldom allowed to close before several months have elapsed. It was previously noted that 12 of the 36 patients still alive who were subjected to cautery pneumectomy still have bronchial fistulas (33 per cent). Some of the 12 patients have declined any attempts at closure because the inconvenience of the fistula to them is slight. There does not seem to be any definite indication that the existence of a bronchial fistula always constitutes a menace. It is, of course, desirable that they should eventually become obliterated. In most instances this takes place by the circular contraction of scar tissue (Bettman) and conversely spontaneous closure is prevented usually because of the inability of the scar tissue around the bronchus to contract because of firm fixation of the lung to the chest wall. Although an acute upper respiratory infection is manifested at the same time by an increase in the discharge of secretions from a bronchial fistula (Graham), there is no evidence that such a fistula predisposes to infections of the upper or lower respiratory tract. It can be argued by some that the persistence of a fistula following cautery pneumectomy detracts from the method. We wish to draw attention to the relative frequency of the bronchial fistulas following partial or total lobectomy by other methods in the presence of bronchiectasis of the type which we consider favorable for cautery pneumectomy. After an incomplete lobectomy, and many lobectomies are of necessity subtotal, expectoration continues. Following cautery pneumectomy the discharge of secretions is on the dressing and is therefore obvious. It is, of course, possible to obliterate the fistula produced by cautery pneumectomy by a variety of methods. The method which has been employed successfully on a number of occasions by one of us (E. A. G.) is illustrated in the following report:

CASE 16.—Cautery pneumectomy for chronic lung abscess and bronchiectasis.

Result: Patient well and actively at work.

Remarks: Closure of bronchial fistulas by plastic operation.

D. N., white man, aged thirty-eight, was admitted to Barnes Hospital on June 6, 1927, complaining of cough and foul expectoration. This patient suffered a compression injury, left chest, with fracture of rib in 1910. He then coughed up blood for a period of two months but apparently recovered completely and was then

quite well except for an occasional cold until December, 1926. He then began to suffer from cough, foul expectoration and loss of weight. His condition was recognized and he was admitted to Barnes Hospital with the above mentioned diagnosis.

He received four pneumothorax treatments without obtaining any relief, and was therefore subjected to an operation on July 6, 1927. Portions of the sixth, seventh and eighth ribs, left, were removed for a distance of about four inches each. The pleura was found to be adherent only in the axillary line. Anteriorly it was not adherent. The lung was therefore sutured to the parietal pleura but during the suturing an abscess ruptured spontaneously. About 5 c.c. of thick, foul smelling pus escaped from the abscess.

On July 16, 1927, a multilocular cavity containing about 30 c.c. of thick foul smelling pus and several small cavities were cauterized. One large cavity resulted. By July 30, 1927, the patient was entirely free from cough and expectoration and was therefore allowed to be up in a chair. The cavity was almost entirely obliterated by August 17, 1927. Only a moderate amount of discharge and several bronchial fistulas remained. He left the hospital on December 5, 1927. He felt fine, had gained in weight. There was practically no discharge from the wound.

After failure of the bronchial fistulas to close spontaneously in nearly two years it was decided to obliterate them by operation. A phrenicectomy was therefore performed on October 12, 1929. The size of the anatomical defect was slightly reduced. A thoracoplasty was next undertaken and portions of the seventh to first ribs, inclusive, were removed on December 7, 1929. Great care was taken to keep away from the fistula to avoid soiling the wound.

The fistulas were finally closed by a plastic operation which was performed on January 7, 1930. The operative note on this occasion reads as follows: "Old scar reopened around fistulous opening. Armour plate of new bone formation made it very difficult to obtain desired access to the lung. The reason for the failure of the spontaneous closure of the fistulas was readily apparent when it was found that they were adherent to a rib above and one below. The fistulas were opened wider, then a small cavity whose capacity was estimated at about 25 c.c. was entered. Several large bronchi opened into this cavity. The fistulous canal was removed with the actual cautery and the cavity was then obliterated by closing its edges with three rows of purse string No. 1 chromic catgut. The whole area was later covered by drawing scarred tissue from each side over it. Closure seemed satisfactory in every respect. A small rubber dam drain was inserted into the wound and the skin was closed with both silk worm suture and continuous suture of silk." (Fig. 32.)

The patient was discharged from the hospital on February 20, 1930. His wound was entirely healed and has remained so since. He has remained completely free from symptoms.

Anderson, in 1928, reported the successful use of the cautery for chronic pulmonary suppuration according to our technic. This patient was able to return to work with his wound solidly healed.

Bettman has found the method of cautery pneumectomy satisfactory and in a personal communication has furnished us with the results that he obtained in five cases. Four of the five patients are considered to be clinically well. Three are entirely healed and one has a small bronchial fistula. There was one death. We quote from his communication:

"1st Case—Bondy, male, age eighteen. History of trauma to the lung, lung abscess and empyema, as a young child. Since then, chronic empyema with bronchial

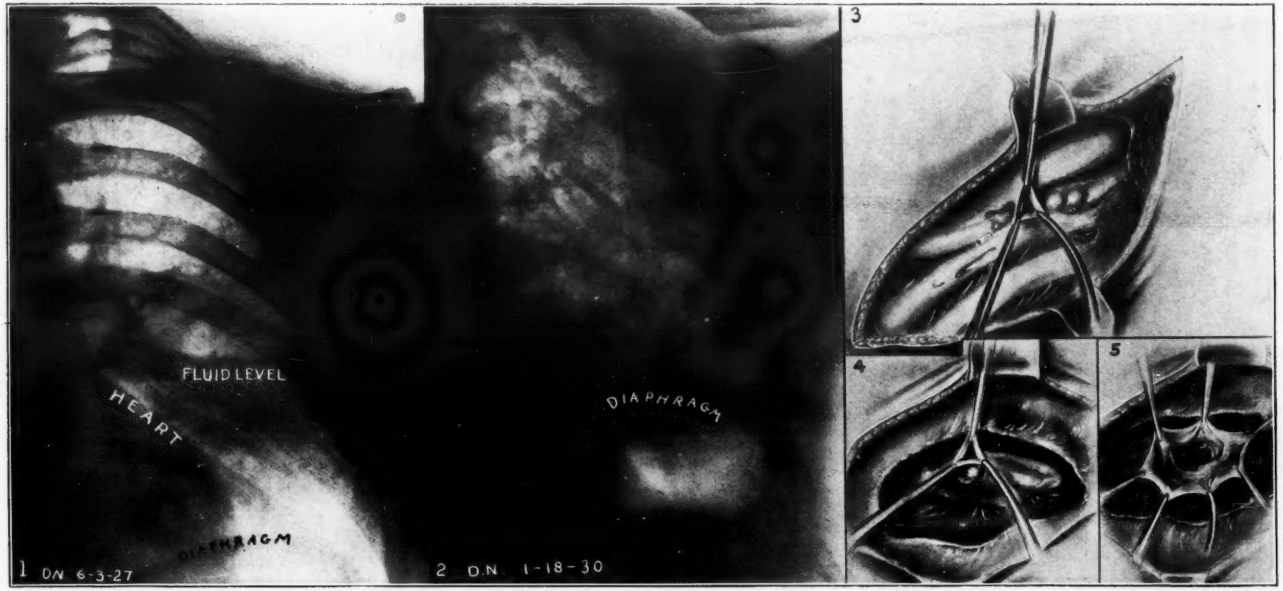

Fig. 32.—Method of closure of large bronchial fistula after cautery pneumectomy for abscess of the lung and bronchiectasis:
This figure refers to the patient in Case 16. Fig. *1* shows the condition of the lung before the operation of cautery pneumectomy. There was a fairly large chronic abscess with fluid level and bronchiectasis around the abscess. Fig. *2* shows the appearance of the lung after the bronchial fistulas had been obliterated. Note the elevated diaphragm (phrenicectomy) and some of the regenerated ribs. The technic employed to close the bronchial fistula is illustrated in Figs. *3*, *4* and *5*. The reason why spontaneous closure failed to occur became apparent when it was found that the tissue about the fistulas was adherent to the adjacent regenerated ribs (*3*). These ribs were removed and the external opening (*4*) then opened wider in the manner indicated in *5*. It was treated by the actual cautery. Three rows of purse string sutures were used to complete the obliteration of the cavity. The whole area was then covered by inverting lung tissue into it with a series of purse string sutures.

fistula, and all signs and symptoms of bronchiectasis at left base. Sputum so foul that it interfered with child's schooling. Cautery pneumectomy by me about four or five years ago. Removal of the entire lower lobe so that the posterior pericardium could be seen and electrocardiographic tracings made therefrom. Removal of the lobe within a period of about two months. Convalescence was stormy with two severe hemorrhages which required blood transfusions. The boy is now perfectly well, working daily in an office with many other people, no detectable odor to his sputum and except for a persistent bronchial fistula is normal."

"2nd Case—Borja, male, age forty. Multiple lung abscesses in the middle lobe of the right lung. Partial pneumectomy excising, in a period of about three weeks, a portion of the middle lobe and lower lobe of the right lung. Result excellent. No bronchial fistula."

"3rd Case—Tractenberg, male, age thirty. Massive involvement, multiple abscesses and bronchiectasis of entire left lung, subsequent to a pneumonia of the left lung. Present condition of five years' duration. Multiple stage thoracoplasty and phrenicectomy unsuccessful. Attempted cautery lobectomy. Man died following the first stage of the operation. (This man was a terrible risk and died with a pneumonic involvement of the other side.)"

"4th Case—Briarman, male, age eighteen. Multiple lung abscesses of lower lobe of the left lung subsequent to a pneumonia. Duration of disease about a year. Removal of a large portion of the left lower lobe. The operation was accompanied by two severe hemorrhages which were controlled by packing but for which blood transfusions were also done. Clinical cure; bronchial fistula closing spontaneously in about a year. Boy has been well and at work for two years."

"5th Case—Wolfson, male, age fifty. Pneumonia, empyema with bronchial fistula, lung abscess right lower lobe with beginning gangrene of the lung. Operation—primary empyema drainage, later opening of lung abscess and finally partial cautery pneumectomy to remove gangrenous portion, removing about one-third of the right lower lobe. Although this was done on an acute case in a patient who was septic and toxic, there was a steady improvement in the patient's condition. He left the hospital within two months after the opening of the lung abscess and is now completely cured with the bronchial fistula healed."

Coquelet has modified our procedure of cautery pneumectomy. He removes wedges of lung tissue. He has performed this so-called "cunéo-pneumectomie" on six patients. Three were completely cured without fistula, one patient was cured of his suppuration, but still has an open cavity. The fifth patient is still receiving treatment but is considerably improved and one patient died of massive bronchopneumonia in the opposite lung.

Denk uses the cautery after performing a partial lobectomy according to the method described by Brauer.

XXI. TREATMENT OF BRONCHIECTASIS BY LOBECTOMY

After a fairly extensive trial of lobectomy for bronchiectasis by several surgeons throughout the world, there was an interval of several years during which relatively few reports of such an operation appeared in the literature. It seemed as if the procedure had been generally abandoned, probably because of its high operative mortality. Recently, however, in Canada and the United States the operation has been ex-

tensively revived by several surgeons who have proposed various modifications in operative technic. Personal communications from some of these surgeons permit us to include many of the recent results in this article.

With the recent reports that are now available 212 cases in which lobectomy has been performed (Table IX). This would seem to be an adequate number from which to draw conclusions. In analyzing the results we have been interested particularly in a number of features. The most important is the operative mortality. It will then become necessary to consider whether lobectomy was really indicated in every instance; in addition whether the fact that the results which are reported as definite improvements and not as clinical cures does not constitute an admission that either the lobectomy performed was subtotal or that diseased tissue remained, possibly in another lobe. It is important also to realize that before the refinement of roentgenologic diagnosis of pulmonary disease (about 1923), some were probably submitted to lobectomy who would not be considered as suffering from this condition now. This discrepancy might affect both mortalities and final results.

Thus, 16 pneumectomies for bronchiectasis with 8 deaths (50 per cent) were reported up to 1914. Seven of these were apparently done in the presence of adhesions, with 6 recoveries and 1 death. Three were done in the absence of adhesions between the pulmonary and costal pleurae, with 1 recovery and 2 deaths. No statement has been made regarding the presence or absence of pleural adhesions in the remaining 6. Of these 1 improved and 5 died. It is rather difficult to determine the type of dilatation present in these cases and whether there were any in the adjacent lobes.

One cannot consider that a cure has been obtained if any dilatations persist, this fact is sometimes overlooked. We find for example that Willy Meyer has been credited with a successful lobectomy. A careful examination of his report reveals the fact that his patient still suffered from "a few distended and chronically inflamed bronchus divisions" and that she still had scanty expectoration. An acute respiratory infection could make such dilatations discharge considerable secretions.

In a personal communication Lilienthal states that he has submitted 42 patients to lobectomies. This group of resections includes some subtotal pneumonectomies and cases in which resection of the greater part of a lobe was performed. The lesion was in every instance nontuberculous. Twenty-seven (64.3 per cent) of these patients are dead as a result of the operation. One patient, not among the 27, died more than 9 years after an extensive pneumectomy when the left upper and part of the lower lobe had been removed. This patient was well save for a bronchial fistula, was active and was apparently in good health. He died rather suddenly from pulmonary tuberculosis. The findings in this case were confirmed by necropsy. The above is the only subsequent death which occurred among the 15 patients who recovered. Four other patients

TABLE IX

LOBECTOMY FOR BRONCHIECTASIS (212 CASES)

SURGEON	NO. CASES	TYPE OP. NO. STAGES	ANAES.	RESULTS						
				C.	D. I.	I.	N. I. U.	OP. D.	SEC. D.	BR. FIST.
Collected Cases Up to 1914 (W. Meyer)	16			8				8 (50%)		
Meyer, W.	1	M	Ether		1					
Lilienthal, H.	42	M	Ether	10	4			27 (64.3%)	1	4
Robinson, S.	7	M	Ether	4 ?				3 (43%)		
Hanson, P.	4			3				1 (25%)		
Hitzrot, J.	1			1						
De Quervain, F.	1	M		1						
Graham, E.	6	M	Gas-O	2		1		3 (50%)		1
Sauerbruch, F.	38✓	S & M	E ?	27 ?	5	2		4 (10.5%)[1]		
Archibald, E.	9	S	Gas-E	5				2 (22%)	2	
Guibal, L.	6	M		1				5 (83%)		
Zaaijer, J.	1	M		1						
Whittemore, W.	12	S	Gas O	7		2		3 (25%)		
Hedblom, C.	4	M		2				2 (50%)		
Brunn, H.	8✓	S	Avert.	6			1 ?	1 (13%)[a]		
Shenstone, H.	16	S	Spinal	6		2	3 (2 U)	3 (18%)		
Coryllos, P.	7	M	Spinal	5				2 (28%)		1
Alexander, J.	12 ✓	M ✓	Gas-O	5 ✓	2 ✓	2 ✓	1 U✓	2 (16%) ✓		1 ✓
Nissen, R.	1	M	Ether	1						
Denk, W.	5	M		1	2	1		1 (20%)		3
Harrington, S.	6	M		1	3			2 (33%)		3
Bettman, R.	1	S						1		
Churchill, E.	4	S & M	Gas-O	1	3					1
Flick, J.	3	M	Gas-O	1				2 (66%)		
Dolley, F.	1	M		1						

M = Multiple, S = Single, O = Oxygen, E = Ether, Avert. = Avertin, C = Cured, D. I. = Definitely improved, I = Improved, N. I. = No improvement, U = Uncertain (early result), Op. D. = Operative death, Sec. D. = Secondary death, Br. Fist. = Bronchial fistula.

have bronchial fistulas, one permanent, the other three expected to heal. The last four consecutive cases are entirely well or convalescent with bronchial fistulas which are expected to close. Lilienthal is convinced that all these 42 patients would have been dead by this time without operation and that none of them would have been perfectly well without lobectomy.

Lilienthal is of the opinion that better results can be expected when the operation is divided into two stages, particularly in those cases in which adhesions of the lung to the chest wall are not present at the time of exploration. His present procedure at the first stage is: "A long thoracotomy through an interspace, usually the seventh, when a lower lobe is to be resected, or, in contemplated upper lobe resection, a continuation of the incision upward posteriorly with the division of three or more ribs, so that ample space may be had by retraction. Adhesions are secured by rough friction with gauze dipped in tincture of iodine. At this first stage there may be a long resection of one rib or none at all according to the possibility of spreading with retraction or because of the need of speed. A dependent opening is made with valvular tube drainage and the large wound is completely closed by sutures. A week or more later the second stage of the lobectomy is performed. The stump is isolated, crushed, and ligated in sections with heavy chromicized catgut, the ends of which are left protruding from the wound posteriorly. A large stump is left and every vessel whose mouth can be seen is separately ligated. This is done because in many of these cases the pedicle is indurated and the vessels contained therein may not have been crushed sufficiently so that early atrophy may permit reestablishment of the lumen. The long ends of the stump ligatures are drawn out of the wound posteriorly and are fastened in place with a safety-pin after tying them together. The wound is then closed and covered with an occlusive dressing, but the original low drainage tube is left in place outside the dressings and good valvular suction drainage is provided."

Lilienthal has recently preceded the operation of lower lobe removal by avulsion of the phrenic nerve. He apparently considers this procedure advantageous.

It is interesting to note that one of his patients had a greater vital capacity following the complete removal of his right lower lobe than he did before the operation.

Robinson, in 1917, reported 5 resections of the lower lobe of the lung for bronchiectasis with 1 death. In a subsequent report, however, this number was increased to 7 lobectomies with 3 deaths.

In the first communication it is noted that the patient referred to in Case 1 died of pneumonia 4 years after the lobectomy was performed. The dilatations in the second case were of the cylindrical and saccular variety, chiefly the latter. Case 3 was one of chronic abscess of the lung, bronchiectasis and pneumonitis. This patient died from a septicemia which followed upon an empyema. The bronchiectasis in Case 4 was of the saccular variety. The dilatations in this case apparently resulted from a foreign body, but it is worthy of note that there were dilatations in the basal portions of the upper lobe and that these persisted after the lobectomy. Dilatations in the fifth case were also of the saccular type.

Hansen (1917) has reported 3 cures and 1 death. Hitzrot (1920) reported a successful lobectomy. The lesion in this case was a bronchiectatic cavity. There were also miliary abscesses about the bronchi and a bronchopleural fistula. de Quervain has also reported a successful lobectomy.

At the 1922 meeting of the Association for Thoracic Surgery one of us (E. A. G.) reported three lobectomies for bronchiectasis with one cure and two operative deaths. The operations were performed in two or more stages. In the first case, which was the successful one, it was noted that the comparatively slight postoperative difficulty was due probably to the fact that the uninvolved upper lobe was firmly adherent to the chest wall. In the published report of these cases the comment was made, "Any procedure which will permit the easy and safe creation of firm adhesions between the unaffected portion of lung and the chest wall will serve greatly to reduce the mortality of the operation, for the double benefit of a minimum of pleural cavity to be infected and a minimal amount of respiratory disturbance during and immediately after the operation will result." In the two fatal cases an effort was made at a preliminary stage to create such adhesions. One of the patients died apparently because the attempt was unsuccessful and the other on the fifth postoperative day from an extensive bilateral bronchopneumonia, although firm adhesions had been produced successfully between the upper and middle lobes and the chest wall as a result of surrounding the lower lobe with gauze at a preliminary stage of the operation. It is probable that the fatal pneumonia was induced by the spilling over of secretions from the infected lobe into the healthy portions of the lung at the time of lobectomy, a danger which has been particularly emphasized by Archibald.

The technic used in the successful case is noted in the following case report:

CASE 17.—Male, aged seventeen, was recommended to Barnes Hospital on November 1, 1920, and was found to be suffering from bronchiectasis involving the left lower lobe. He had had chronic cough for 15 years previous to admission. This cough had been accompanied by the expectoration of nearly a pint of foul sputum in 24 hours. The sputum was occasionally blood streaked but there were never any active hemorrhages. The patient had learned to drain himself with good results by posturing. He had carried this on for some time. He had also been subjected to pneumothorax treatments without benefit by Dr. Sale, and had also spent several months in Colorado. His sputum was repeatedly negative for tubercle bacilli. The etiology in this case was uncertain. The condition had started insidiously at the age of two and at the age of five he had suffered from the bronchopneumonia of measles and at six from whooping cough.

Physical Examination.—The patient was fairly well nourished and somewhat cyanotic. There was marked clubbing of the fingers and toes, prominent mammary glands, offensive breath, slight asymmetry of the chest. The left side of the chest was flattened, with limited expansion. The chest circumference on the left side was 17.25 inches; it was 18 inches on the right side; chest expansion was 1 inch. Tactile fremitus was decreased over the entire left chest. There was dullness over the left lower lobe. The heart was displaced somewhat to the left; there were no murmurs, but slight sinus arrhythmia. The systolic blood pressure was: 110, the diastolic, 65. The liver was slightly palpable. There were no pathologic reflexes. The Wassermann reaction was negative. The patient's temperature was 98.2° F., his pulse, 80, and his respirations, 18. His blood count showed: 5,040,000

erythrocytes, 9,580 leucocytes. The hemoglobin was 90 per cent. The urine was normal, the electrocardiogram likewise. The roentgen ray revealed an extensive infiltration of the left lung toward the base, with pulling over of the heart to the left. There was an area of pneumothorax in the left apex.

Operation.—(E. A. G.) The first stage of the operation was performed on November 6, 1920. About 5 inches of the seventh, eighth and ninth ribs were resected (left), from the angles to the mammary line. The corresponding intercostal bundles were excised. The pleura was apparently adherent and was not opened. The first stage terminated after closing the skin with silkworm and silk sutures, without drainage. There was no marked reaction to the first-stage operation, but elevation of temperature of 1 degree, a faint trace of albumin in the urine and a few hyaline and granular casts. Healing occurred by primary intention. November 22, the old flap was turned up; the pleura was opened, with but little change in the respiration at first. The upper lobe was adherent to the parietal pleura. There were also extensive adhesions between the diaphragm and lung. The lower lobe was dark, firm and nodular. Adhesions between the lung and diaphragm and chest wall were broken up with the finger. Gauze soaked in petrolatum was packed about the lower lobe. The second stage was terminated. The reaction was more severe after the second stage than after the first. The temperature on the following day was 101° F.; pulse 110; respiration, 22. There was considerable discharge of bloody serum. On the 6th day after operation, the packing from the chest was removed, under nitrous oxide anesthesia, and three Carrel tubes were inserted for irrigation with Dakin's solution. The temperature continued to be elevated reaching a height of 104° F., until the 9th day after operation (December 1), when it fell to practically normal and remained so until the third stage of the operation.

On December 31 the third stage of the operation was carried out under nitrous oxide anesthesia. The old incision was reopened and the lung was found to have retracted upward somewhat. In order to provide more space, about 4 inches (10 cm.) of the fifth and sixth ribs were removed. The lower lobe was densely adherent all around. Many adhesions had to be cut. The greatest difficulty was in separating the adhesions between the lung and the diaphragm. The separation between the upper and middle lobes was easy. Curved clamps were placed on the hilus, and the lobe was amputated. The clamps were left in position. The wound was packed with petrolatum gauze and covered with several pads to exclude air. The operation was well tolerated and lasted forty-five minutes. January 3, the clamps were removed from the hilus without bleeding and with no evidence of bronchial fistula. There had been very little reaction to this stage of the operation. The maximum temperature was 102° F., with an average of about 100° F. The average pulse rate was 130; respiration 25. There was no cough. Dakin irrigations were continued regularly from the time of removal of the clamps. January 8, the patient tasted Dakin's solution for the first time and began to cough during irrigation. January 10, a bronchial fistula was observed. Instead of ordinary Dakin's irrigations, one irrigation a day was substituted, with the patient in the sitting posture, care being taken to avoid entrance of fluid into the fistula. Recovery was practically uneventful except for an attack of acute tonsillitis. He was discharged from the hospital, February 19, with a bronchial fistula about the size of a lead pencil. This healed completely and spontaneously, about 2 months later. It has remained healed ever since.

This patient has been well and at work for over ten years. He indulges in athletics and is an amateur boxer of considerable ability. (Fig. 33.)

The method of creating adhesions between the unaffected portion of the lung and the parietal pleura which has recently been used by Alexan-

der seems preferable to the one used by us in the two fatal cases of our series. A description of Alexander's method will be found at another place in this article.

One of us (E. A. G.) has also performed three subtotal lobectomies according to a method described by Whittemore in 1927. One of the patients died. In one of the other cases the persistence of bronchial fistulas with a copious discharge of pus made the result unsatisfactory. It will probably be necessary to remove the remaining portion of the lobe. In the third case an entirely successful result was obtained from

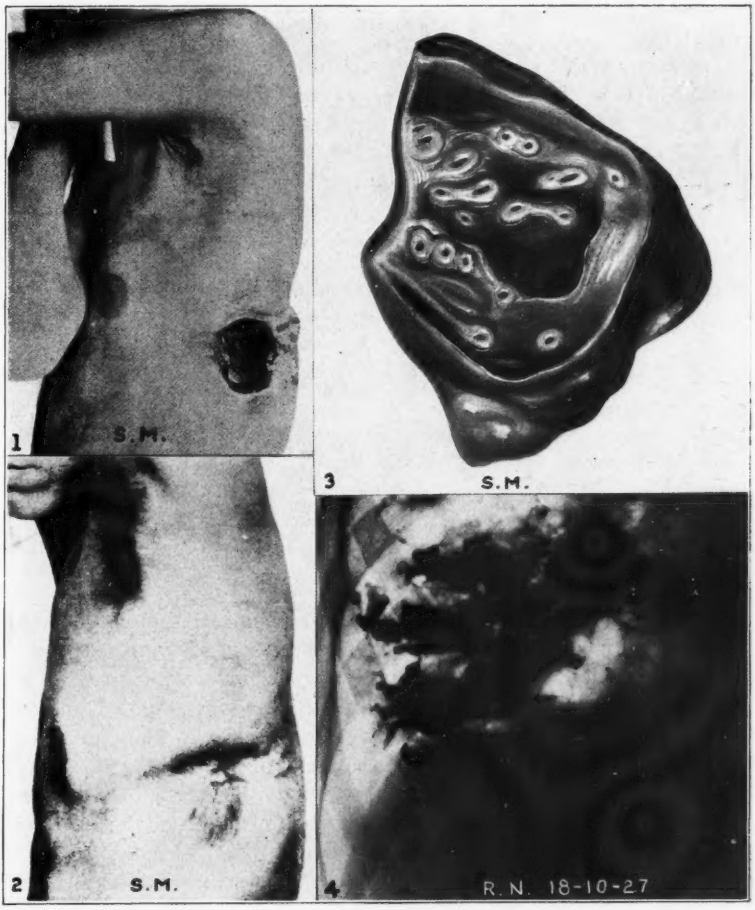

Fig. 33.—Lobectomy for bronchiectasis. (Case 17.) (*1*) Appearance of the wound six weeks after lobectomy. A bronchial fistula was present at this time. *2*, shows the wound completely healed three months after the lobectomy had been performed. *3*, the resected lower lobe of the patient referred to in Case 17. Fig. 4 represents the type of dilatations present in the patient referred to in Case 18.

a two stage operation performed seven years ago. At this operation a lower lobe was exteriorized and ten days later the portion outside of the skin was cut off with the cautery. Moreover, it should be stated that in several instances in which a cautery pneumectomy has been performed actually a subtotal lobectomy has been accomplished. See, for example, Case 12.

CASE 18.—R. B. N., male, aged 13, was first admitted to St. Louis Children's Hospital on November 7, 1927. His complaints were cough and foul expectoration, which had followed an attack of pneumonia when he was two months old. He had another attack of so-called pneumonia when he was six months old, a third when two and one-half and a fourth when he was six years of age. Following the fourth attack he developed a right-sided empyema which had to be drained. His complaints became progressively worse, however, and he lost in weight and strength. He occasionally had a slight fever but apparently no chills. Physical findings were entirely limited to the right chest. There was marked clubbing of the fingers and toes. A bronchoscopic examination by Dr. Arbuckle on November 7, 1927, revealed pus coming from the right lower lobe. There was no evidence of foreign body. The clinical diagnosis was multiple lung abscess and bronchiectasis. (Fig. 33, No. 4.) The child remained in the hospital only for the day at this time, but was readmitted two weeks later. About four inches of the eighth, ninth, and tenth ribs were removed (E. A. G.). The right lower lobe was found to be firmly adherent to the diaphragm, to the lobe above and to the chest wall. It was considerably atelectatic and somewhat cyanotic, but no area of induration could be felt in it. The lobe was separated and was delivered outward and anchored into position outside of the chest wall by numerous sutures. These sutures were of braided silk and catgut. During the operation the boy's condition became very bad because of interference with respiration. This was accompanied by marked cyanosis and was probably due to obstruction of the trachea by the thick pus which was spilling out from the diseased lung. The lobe was anchored in place outside of the wound and was surrounded by vaseline gauze. The final stage of the operation was performed on December 2. Deep sutures of braided silk were then taken through the lung substance because it was found impossible to apply clamps conveniently to any pedicle. After tying these sutures of braided silk the exposed portion which composed two-thirds of the lobe was cut off with a cautery. Very little bleeding occurred. Bleeding vessels were caught with forceps and ligated separately.

The excised portion of the lung in this case presented an appearance which was rather suggestive of congenital bronchiectasis with atelectasis. The lipiodol injection picture already referred to shows the presence of saccular dilatations. The operation in this case was attended by considerable improvement but bronchial fistulas persisted. These were due to the presence of dilatations in the remaining portion of the lobe. The patient has grown and his strength and nutrition are at the present time good. He has recently been readmitted to the hospital for the removal of all the remaining diseased tissue.

It is rather difficult to tell just how many lobectomies Sauerbruch has performed. Hedblom states that Sauerbruch performed a single stage lobectomy on 3 patients, all of whom died of tension pneumothorax from leakage at the bronchial stump. He also states that Sauerbruch performed 7 lobectomies after extrapleural thoracoplasty with only 1

death. Sauerbruch himself, in 1927, reported 23 lobectomies for so-called congenital lower lobe bronchiectasis with only 3 deaths. These operations were all performed in more than one stage. In a publication which appeared in 1929, Denk stated that Sauerbruch had performed 26 lobectomies for bronchiectasis in several stages with only 3 deaths. Sauerbruch is also reported (cited by Denk, 1929) to have performed 10 other lobectomies. The technic in these cases apparently differed, the diseased portions of the lung being removed in several stages. There were 3 deaths in this series of ten, 5 definite improvements and 2 slight improvements. In a very recent discourse Nissen refers to the fact that 38 lobectomies had been performed at the Charité, Berlin, with a mortality of 10.5 per cent.

In a personal communication Archibald states that he has 9 cases of total lobectomy for bronchiectasis. "Sex: 2 female, 7 male. Age: twelve, fifteen, fifteen, twenty-two, thirty-four, twenty-six, thirty-seven, forty-one, fifty-one. Lesion: bronchiectasis, dry hemorrhagic, 1; bronchiectasis, suppurative, 5; bronchiectasis, suppurative, with multiple abscesses, 3. In 2 cases the condition was caused by tumor of the left stem bronchus, one a sarcoma and one a carcinoma. In 2 cases suppurative bronchiectasis was present in the upper as well as in the lower lobe. In all the rest it was confined to one lower lobe. Etiology: in 7 the condition began as a respiratory infection. In 1, following tonsillectomy, and 1 following aspiration of a foreign body. Duration of illness from onset varied from 1½ years up to 21 years. In 5 the condition was complicated by recurrent hemoptyses. In 3 the patients were running fever of 101. In all but 1 (the first, 1922) the condition was proved by lipiodol injection. There were 2 deaths following the operation of lobectomy; one from acute mediastinitis on the 4th day; one from secondary hemorrhage, and bronchopneumonia after 60 hours; a third death occurred from bronchopneumonia of the good side several months after the operation of lobectomy, as the result of a small operation for the removal of recurrent sarcoma in the chest wall. Finally, a fourth death occurred 4 days after the removal of the upper lobe and lung stem for carcinoma of the left stem bronchus, from septicemia, a lobectomy of the left lower lobe, for bronchiectasis, having been done about two months previously, with success. The death rate, therefore, dependent upon the operation of lobectomy, is 2 out of 9, the 2 other deaths being due to later operations connected with cancer of the stem bronchus.

"*Technic.*—In 7 of the 9 the technic has been approximately that of Shenstone, of Toronto. That is, a one-stage operation, through a long intercostal incision, or with resection of one rib, with tourniquet for the stump, to control hemorrhage, and another tourniquet on the lung, to prevent outflow of pus, with the formation of a lung cuff, ligation separately of bronchi and vessels and covering over of the stump with the lung cuff, followed by a complete closure, with closed drainage and continuous aspiration." However, in the last four cases Archibald has added to this procedure what he expects will prove a very valuable measure of safety; namely,

the preliminary introduction of a small inflatable balloon into the stem bronchus of the diseased lung. His analysis, several years ago, of the cause of death following operation for lung abscess and bronchiectasis, showed that much the most frequent cause of death was acute infection of the good lung, from the aspiration of pus, during anesthesia, from the diseased lung. "The method of the inflatable balloon is a modification of Waters' method of intratracheal anesthesia, and was suggested to me by Dr. Harold Griffiths, anesthetist to the Homeopathic Hospital, of Montreal, and the tube that he uses is a modification devised by Dr. W. B. Howell, chief anesthetist to the Royal Victoria Hospital." The instrument consists simply of a gum elastic Coudé catheter, to the end of which has been attached a rubber balloon, as in Waters' apparatus." In one of these 4 cases, operated on by his assistant, Dr. Norman Bethune, the bronchus was plugged by a pledget of cotton wool, introduced through a bronchoscope, with a string attached. Hitherto the procedure has been to anesthetise the patient completely, with gas and ether, in order to insert, without causing coughing, the rubber balloon. This is then done, guiding the Coudé end towards the side of the diseased lung. It is found that the catheter goes invariably into the stem bronchus of that side, without the necessity of control of vision, as through a bronchoscope. Then the ordinary intratracheal catheter is also inserted, and further anesthesia is carried out, with gas-oxygen. Respiration has been in all cases quite satisfactory even with the whole of one lung blocked off. It is proposed in the future, in order to avoid the danger of coughing and expulsion of pus during inhalation anesthesia, to begin with intravenous or rectal ether. In fact intravenous ether has been used in one patient, but the dose was too small and results unsatisfactory.

"The technic of lobectomy in the first case, in 1922, was published in the Canadian Medical Association Journal, in March, 1924. It consists in a preliminary thoracoplasty, followed at a second stage by exteriorization of the lung, and removal of the lobe on the surface, leaving the stump practically between the inturned skin edges." Archibald has abandoned this method, because it leaves a bronchial fistula close to the surface, which is difficult to close, and because the preliminary thoracoplasty hardly seems necessary, and in itself involves some danger. In practically all his cases the diseased lobe has been more or less adherent, except in the first one, the child of 12. The upper lobe has also been, in most cases, adherent, which represents a factor of safety as regards the danger of mediastinal mobility. In practically all his cases the condition has been advanced, often septic, and usually with chronic pneumonitis and miliary abscesses.

Guibal, who is credited by some as having performed the first successful two-stage lobectomy, has reported 6 lobectomies with 5 deaths. Zaaijer has reported a successful lobectomy.

Whittemore has reported 10 lobectomies performed after exteriorization of the diseased portion of the lung. Seven patients recovered and 3 died, a mortality of 30 per cent. Two died of pneumonia in the good lung, the first 10 days after operation and the second 2 weeks after the operation. The third patient died from a streptococcus septicemia 5 weeks after the operation. Six of the 7 patients who recovered are stated to be in good condition. Four of these have no sputum and 2 do not expectorate more than a teaspoonful of sputum every twenty-four hours. The seventh patient is well as far as the side operated upon is concerned, but has developed disease in the other lung. The wounds of all of these patients are healed and their bronchial fistulas apparently closed

without the necessity of any further surgery. In addition to the above mentioned cases, in a personal communication, Whittemore states that he has had 2 cases in which he could not deliver the lobe satisfactorily. In these cases he packed gauze around it with the result that the lobe gradually sloughed away. One patient is perfectly well as a result of this procedure and the other left the hospital much improved and with a sinus. This patient has been lost sight of, but he was known to be doing well three or four months after leaving the hospital.

The technic which Whittemore employs has been described by him in the following manner: The pleural cavity is opened after the section of a considerable portion of the seventh rib. The opening is spread widely. If lobectomy is then decided upon sections of a sufficient number of ribs are removed so that the lobe can be delivered from the pleural cavity after adhesions and the pulmonary ligament are divided. The lobe is then sutured to the muscles of the chest wall, the sutures being placed as near the root as possible. In some instances Whittemore has placed an elastic tourniquet about the root of the lobe. The lobe is then surrounded by gauze, a catheter directed to the root of the lung and the wound closed. The lobe is allowed to slough away gradually and this is usually accomplished in three to four weeks. The pleural cavity becomes obliterated by the inflation of the upper lobe and the rise of the diaphragm, and in Whittemore's experience during this period the fistulas become closed. Drainage is to be maintained until the cavity is obliterated. In certain instances Whittemore recommends the performance of a preliminary thoracoplasty.

In a recent personal communication Hedblom states that he has performed 4 lobectomies, all of them secondary to thoracoplasties and originally performed for chronic bronchiectasis of years' duration. One patient died on the table during the process of separating the lung from the hilus. As far as Hedblom could tell the pleura had not been incised or torn, and so he is unable to decide whether the death was due to an air embolus or to a reflex. The second patient did well for a few days postoperatively but developed a streptococcic pericarditis from which she died in the second week. Two patients were cured, they are free from cough and expectoration and there are no bronchial fistulas remaining.

The technic used was to make a window through the lateral chest wall, and after the lung had been separated to the hilus, clamps were placed around the hilus and the lung cut away. The pedicle was then sutured with chromicized catgut. In his cases the pedicle was so fibrous that this was very easy to perform. Hedblom states that the 2 patients who recovered showed remarkably little constitutional reaction from the operation itself. The operation was performed in two stages, the lung being separated first, since this was the more difficult procedure, and in as much as the lung was thoroughly adherent to the diaphragm. Hedblom also reports that he has performed several partial cautery pneumectomies for bronchiectatic abscesses with good results.

Brunn, in 1929, reported 6 lobectomies with 4 cures, 1 improvement and 1 death. There is little data concerning the first case but it is noted that the lower lobe on the non-operated side was also involved. The specimen in the second case showed chronic bronchitis with marked

bronchiectasis apparently of the sclerotic variety. The lobe in the third case is described as being somewhat small and presenting the appearance of a collapsed lobe. The walls of the main bronchial branch were thickened, the lobe contained 4 large elongated sac like structures that ended blindly. Much of the parenchyma presented a normal appearance. The specimen in the fourth case showed large thick-walled bronchiectatic cavities. These cavities appeared shrunken after fixation of the specimen. The patient referred to in case five was the one who died following the lobectomy and his lobe showed bronchiectasis with interstitial and organizing pneumonia. The lung in the sixth case was definitely atelectatic, the bronchi were prominent but not dilated. It was concluded that the lesion was chiefly one of subacute organizing pneumonia and interstitial pneumonia. This patient was operated on September 7, 1927, and died on June 6, 1928. He was then found to be suffering from a primary carcinoma of the right lung. In a recent personal communication Brunn states that he has now performed 8 lobectomies with 1 death. The seventh patient (A. V.) made a remarkable recovery. The eighth patient (M. T.) was operated upon March 16, 1932. Brunn states she is still running a high fever and that her condition is extremely serious and her recovery doubtful.

Brunn states that he has chosen patients whose conditions were extremely serious, that they all gave every prospect of chronic invalidism and that they did not respond to any marked degree or with any permanency to other forms of treatment. Brunn performs a preliminary phrenicotomy for two reasons. In the first place to quiet the movement of the diaphragm during the operation, and secondly to obliterate dead space. He produces an artificial pneumothorax a few days or weeks prior to the procedure. Firstly to expel secretions and prevent spilling into the other side, and secondly to discover the extent of adhesions between the lung and the chest wall.

The anesthesia which Brunn employs is as follows: A barbital suppository of 15 grains (0.972 gm.) or 10 grains (0.65 gm.) by mouth is given three to four hours before operation. In his previous technic two hours before operation scopolamine 1/200 grain (0.3 mg.) and morphine $\frac{1}{4}$ or $\frac{1}{6}$ (16 or 11 mg.) is administered hypodermically. One half this dose or approximately 1/400 grain of scopolamine (0.15 mg.) and $\frac{1}{8}$ grain of morphine (8 mg.) is repeated one half hour before operation. A syringe containing this same dose is at hand to be used if necessary during the procedure. This method has always given him a good anesthesia along with local procaine. "However, there are at times patients who vary in their response to scopolamine and at the present time we have in avertin we believe a much more satisfactory anesthetic adjunct. Preliminary to the use of avertin, morphine grains $\frac{1}{4}$ is given one half hour before operation to be followed by a rectal instillation of avertin 85 to 100 mg. to the kilo of body weight, depending upon the condition of the patient. Procaine hydrochloride $\frac{1}{2}$ per cent with a drop of epinephrine to the ounce is injected in rather large quantities along the intercostal nerves, both above and below the line of incision."

Brunn's technic is as follows: "The incision is now made either between the seventh and eighth or between the sixth and seventh ribs and extends from the costal cartilages in front to just beyond the angle of the ribs behind. The intercostal space is exposed. Sharp claw retractors are used to spread the ribs apart at the interspace to be entered and the intercostal muscles are severed down to the pleura.

When artificial pneumothorax has been produced the pleura can be opened boldly but when this has not been done a small nick is made in the pleura and the finger hastily covers it in order to allow the lung to collapse slowly and gradually. The interspace is then rapidly opened with scissors, traction being made on the ribs above and below with large blunt retractors. The space thus obtained is usually not sufficient, except in the very young where the ribs are pliable and it is usually necessary in order to obtain sufficient room to cut the ribs with large bone forceps usually at their angle. One or two ribs above the incision may be so severed and if necessary one rib below. A Lilienthal rib spreader is then inserted over gauze pads and the entire chest cavity exposed so that plenty of room may be had for the operative manipulation. It has been noted that early in the procedure the patient frequently becomes distressed. When this occurs we immediately remove the rib spreader, bring the chest back to its normal position, cover the wound with wet towels which are always at hand, and have the lung slightly re-expanded with carbon dioxide and oxygen or NO_2. The pulse and respiration rapidly become normal and when the operation is resumed it is seldom that the procedure has to be stopped a second time. A survey of the chest is now made. The diseased lobe can at times be noted as somewhat contracted or having changed in color, or it may be entirely normal on its surface so that one could not tell of the disease contained within it. The diseased lobe is grasped with lung forceps. The upper lobe—if the lower is being removed—is allowed to collapse against the mediastinum and is covered with a large rubber sheet, and moistened tapes. Adhesions between the upper or lower lobes and between the lower lobe and the diaphragm are now separated either by sharp dissection or between clamps and all bleeding points are carefully tied and the pulmonary ligament which is sometimes well developed is now cut between forceps and tied. The involved lobe is freed as far as possible toward the mediastinum and is held taut by an assistant. The entire wound and pleural cavity is now well walled off with rubber dam and moist tapes.''

Brunn at present manages the pedicle by using a temporary elastic ligature which controls the stump until hemostasis is obtained. ''A small black rubber tube about 12 inches long is placed around the root of the lung and drawn sufficiently taut to produce compression of the vessels. The tube is clamped with a hemostat. Again the tube is made taut and another hemostat placed and finally a third. It may be advisable in certain cases to put a hemostat just above the ligature on the opposite side in order to prevent slipping. This temporary ligature gives good control of the stump and makes easy the placing of stitches and ligatures. Clamps are now placed on the lung beyond to prevent soiling when the lung is excised. These are placed far enough away so that a wedge shaped incision may be fashioned out of the stump, preferably with the actual cautery. This method of using three hemostats gives perfect hemostasis. When the first one is removed control is still obtained and gradual loosening of the pressure on the pedicle is permitted.''

''The bronchus may be cut out somewhat more deeply than the vessels or it may be ligatured leaving only enough projecting to prevent slipping of the ligature. The mucous membrane is cauterized. Both methods have been used. The vessels presenting are grasped one by one and separately tied, after which a running stitch of chromic gut with a lock suture is passed closing the pedicle from the inside. This will usually control most of the bleeding. When this is finished the first hemostat is removed from the rubber tube and if no bleeding occurs a second one is removed. Any bleeding points are further tied until the stump is entirely dry. The pleura is inverted and covers over the raw surface with an interrupted or a running suture so that the stump is entirely closed. The under surfaces of the adjacent lobe is tacked to the stump with a few stitches. It is of the first importance that there be no hemorrhage from the stump and no leakage of air from the bronchus into the pleural cavity.''

Shenstone, in a personal communication, states that he has performed 16 lobectomies with 3 deaths. He has furnished us with the accompanying table (Table X). There were 3 deaths out of 14. Two of the patients are still in the hospital, they make up the total of 16. Six patients are considered cured, 2 as improved and the remaining 3 as unimproved or worse than at the time of operation—in all three cases the result of extension of the disease to the opposite base. There have been autopsies on all three patients who died, two as a result of diffuse septic pneumonia and the third the result of secondary hemorrhage from a perforating branch of the internal mammary three weeks following an otherwise successful plastic operation for closure of a fistula.

Shenstone has employed spinal anesthesia in his last 8 cases, and has found it much more satisfactory than any other that he has employed. He uses between 250 and 300 mg. of novocaine dissolved in 10 to 12 c.c. of spinal fluid, and in no case has he had to use any general anesthesia. His patients are given a sedative of nembutal grs. 3, morphine gr. $\frac{1}{4}$ and atropin gr. 1/150.

Shenstone has furnished us with the following report of the operative technic which he has employed. We quote from this report: "A long incision is made in the general direction of the ribs, passing just below the scapula and extending from a point a few inches above and behind the angle of that bone to the costal cartilages in front. The underlying muscles are severed in the same direction exposing the ribs and intercostal spaces. We have usually chosen the sixth interspace as our portal of entry into the chest though the fifth or seventh appear to be equally satisfactory. The subsequent exposure is much enlarged by dividing the ribs adjacent to the selected interspace as near their vertebral ends as possible and this we have done in each case before entering the thorax: for this purpose, the lateral margin of the erector spinae is dissected medially and the tip of a straight bone-cutting forceps inserted close to the rib which is severed without prior elevation of the periosteum. The intercostal muscles are then carefully divided and a small puncture is made in the pleura through which air is allowed to enter very slowly by plugging the opening intermittently with the tip of the finger. If, following Brunn's suggestion, the patient be impressed both before and during the operation with the importance of avoiding cough, there results from this procedure almost no disturbance of pulse or respiration. When the lung has retracted, the intercostals with the underlying pleura may be divided safely from the costal cartilage to the angle of the ribs and the wound spread widely with self-retaining retractors. An enormous exposure is obtained in this way, giving easy access to the underlying structures. Adhesions are variable: in our experience they are always present in the interlobar fissure and usually so between the lower lobe and the diaphragm. In several of our cases the pleural space was obliterated. Adhesions are separated by a combination of sharp and blunt dissection and great care must be taken to avoid wounding the lung. When the diseased lobe has been completely freed a snare of heavy cord is passed around it as near as possible to the mediastinum and the loop drawn tight in the instrument designed for the purpose. We believe it to be a better method of controlling the pedicle than any other we have seen described and nothing has given us such a feeling of comfort and safety in this operation as this simple device. Without devitalization of the tissue, it controls the blood supply, obstructs the bronchi, provides a solid support during the suture of the

TABLE X

SHENSTONE'S RESULTS

PATIENT	AGE	ADMISSION	DATE OF OP.	CHARACTER OF OP.	DISCHARGE	P. O. DAYS IN HOSP.	TEMPORARY FISTULA	COMPLICATION	RESULT
M. R. f.	19	May 3/29	May 4/29	R. L. & R. M.	June 9/29	36	Yes	Osteomyelitis Rib	Cured
A. D. m.	47	Nov. 24/29	Nov. 30/29	L. L.	Dec. 23/29	23	No		Cured
C. .C. f.	20	Aug. 20/29	Dec. 18/29	R. L. & R. M.	Dec. 23/29	5	Yes	B. Pneumonia	Died
R. L. f.	26	Nov. 5/29	Feb. 21/30	L. L.	May 29/30	99	No		Improved
V. W. f.	23	Feb. 17/30	Mar. 26/30	L. L. & part L. U.	June 30/30	96	No	Empyema (U) Drainage	Cured
J. S. m.	30	Feb. 12/30			April 17/30			Empyema (U)	
		June 30/30	July 2/30	L. L.	Oct. 29/30	89	No	Drainage & Thoracoplasty	Unimproved
L. S. m.	52	Aug. 31/30	Oct. 8/30	R. L.	Oct. 14/30	6	No	B. Pneumonia	Died
D. MeG. f.	14	Oct. 24/30	Nov. 1/30	L. L.	Dec. 17/30	46	No		Improved
K. F. f.	21	Jan. 21/31	Feb. 11/31	L. L.	May 5/31	83	No		Cured
F. L. m.	22	Jan. 28/31	Feb. 27/31	R. M. & R. L.	Oct. 30/31	245	Yes	Empyema & Secondary Hemorrhage	Died
B. O'B. f.	24	Mar. 25/31	Apr. 1/31	L. L.	June 18/31	78	No		Unimproved
M. K. f.	20	July 28/31	Aug. 19/31	L. L. & part L. U.	Oct. 1/31	43	No		Cured
M. C. S. f.	30	Aug. 14/31	Aug. 19/31	L. L.	Oct. 31/31	63	No	Massive collapse right l. lobe	Unimproved
G. H. f.	32	Nov. 23/31	Dec. 9/31	L. L.	Jan. 21/32	43	Yes		Cured
F. T. m.	24		Apr. 29/32	L. L.					Still in hosp.
M. L. f.	17		Apr. 30/32	L. L.					Still in hosp.

pedicle and in addition can be used in limiting mediastinal movement during the operation. For the purpose of preventing the escape of infected material during the section of the lung, a second snare is placed about one and a half inches distal to the first. The general pleural cavity is then protected by moist packs and the lobe cut away, leaving a pedicle three-quarters of an inch in length. The section is best accomplished with curved scissors and the cut surface of the pedicle should be somewhat excavated to assist in the subsequent closure. Frequently one or more bronchi project above the surface: these should be trimmed away and the resultant bare area painted with acroflavine (1-1000). Obvious vessels are caught with forceps and ligated and a running suture of catgut is introduced across the pedicle but not including its pleural margin. The snare is then slightly released and any oozing areas can be included in the suture before it is tied. A further running catgut stitch closes over the pleural margins, an endeavor being made to invert the edges in the process. The snare is then removed and the stump sutured to the under surface of the upper lobe. Packs are removed and the remaining lobe carefully examined for any small tears overlooked earlier.

"A small incision is then made in the ninth interspace in front of the mid-axillary line through which the end of a long tube of about 32° F. calibre is drawn: the fenestrated end of this tube is placed about one inch away from the pedicle of the resected lung and maintained in place by a plain catgut suture inserted into the summit of the diaphragm.

"The operative wound is closed in layers. Interrupted chromicized catgut sutures enclosing the adjacent ribs bring the edges of the long rent in the intercostals easily and accurately together. In our experience the inclusion of the nerves has not caused any lasting pressure neuritis. The muscles are approximated by a continuous suture of chromicized catgut and the skin by an ordinary running dermal suture.

"As soon as the wound is closed the distal end of the drainage tube is placed under the surface of a mildly antiseptic solution contained in a bottle, maintained at least two feet below the level of the chest. The patient is then invited to cough. This act expresses the air from the pleural cavity, permits of the rapid expansion of the lung and prevents mediastinal flapping. At the end of twenty-four hours it has been our custom to attach a continuous siphon drainage to this tube using a column of about eighteen inches of water."

Coryllos, in a personal communication, states that he has performed 7 lobectomies for bronchiectasis with 2 deaths. The ages of the patients were fifteen, eighteen, twenty, twenty-two, twenty-three, thirty-five and forty years. The first 5 lobectomies were performed without a mortality. One death occurred on the 7th day with signs of consolidation of the right (healthy) lower lobe, and the other on the 18th day with signs of cerebral embolism. The lesion was unilateral in every instance, involving the lower lobe except in one case in which generalized bronchiectasis is said to have developed following an empyema. In 2 cases there were x-ray signs of bronchiectasis in the contralateral lung.

One of the successful cases listed by Coryllos as a lobectomy was actually a cautery pneumectomy of the type which we have described elsewhere. On six occasions he performed multiple stage lobectomy similar to that described by Zaaijer. The successive stages include pneumo-

thorax, phrenicectomy, thoracoplasty and then lobectomy. The pneumothorax treatment undoubtedly prepares the mediastinum and slows down lymphatic drain in the diseased lung (Dolly and Wiese). It also permits the opposite lung to undergo compensatory changes. Unfortunately, pneumothorax is not always feasible in cases of chronic acquired bronchiectasis of the sclerotic type. Bronchoscopic aspirations should be carried out during the period of preparation as Coryllos, and others have pointed out. Phrenicectomy merely supplements the pneumothorax and helps to reduce the size of the thoracic cavity on the side operated upon.

In 6 of Coryllos' patients bronchial fistulas followed the operation. These closed in from 4 to 6 months following the operation. In one patient no bronchial fistula resulted.

John Alexander has had some striking experiences with lobectomy in a large series of cases. In a personal communication he has furnished us with the following information concerning the technic of the two-stage total lobectomy as practiced by him. We quote from this personal communication:

"Preoperative Preparation:

"Phrenicectomy will have been performed weeks or months before the lobectomy. Small doses of pantopon without atropine. Thorough postural drainage immediately before operation.

"First Stage:

"Lying on 'good side,' in at least 15° Trendelenburg position. Local and regional anesthesia until pleural cavity opened. Incision through skin and extracostal muscles from angles of fifth to ninth ribs and along ninth rib to posterior axillary line. Sixth, seventh and eighth ribs and sixth and seventh intercostal bundles resected from tips of vertebral transverse processes to posterior axillary line. Light, positive pressure nitrous-oxide oxygen anesthesia is now begun. All of the bare parietal pleura is excised and rib-spreaders are placed. All loose pleural adhesions over the diseased (usually lower) lobe are now broken with the fingers and firm ones cut with scissors. The free edge of the pulmonary ligament is cut and the rest of the pulmonary ligament up to the inferior pulmonary vein is torn with the finger. The entire surface of both visceral and parietal pleurae from the dome of the pleural cavity to the diaphragm is gently wiped with dry gauze. The incised extracostal muscles are next closed snugly with interrupted-continuous sutures of No. 1 catgut, the lung being fully expanded by the anesthetist's raising the pressure in the gas mask before the final stitch is tied. The skin is closed. No drainage. 'Elastikon' dressing. Upon awaking, the patient is got to expectorate all loose secretions, many of which are in the mouth, before the operating table is changed from the Trendelenburg position."

The postoperative care which is employed by Alexander after the first stage is the following:

"Postural drainages at two- or four-hour intervals during waking hours, are begun two hours after operation. Inhalations of carbon dioxide and moderate doses of pantopon are given if needed to aid coughing and expectorating. On the second, the fourth and sixth postoperative days, the lower pleural cavity is aspirated of whatever bloody serum may have collected as a result of the operative trauma. Eight or ten days after operation the patient may get out of bed for a few minutes

each day so as to exercise his vasomotor power. The second stage of the operation is performed ten or twelve days after the first stage.

"Second Stage:

"Same position of patient and table as before. Nitrous-oxide-oxygen anesthesia at slightly increased pressure so as to keep the newly adherent upper lobe from collapsing and destroying the adhesions over it. With the fingers the original incision is split open and the diseased lower lobe is completely freed from its newly formed adhesions. Care is taken in separating it from the upper lobe that the upper lobe is nowhere freed from its attachment to the parietes. Usually in freeing the lower lobe, encapsulated pockets of pleural fluid between it and the diaphragm, mediastinum and upper lobe are opened. A large fully curved liver needle, threaded with a 90 cm. length of heavy braided silk that has not been sterilized more than once, is held in the fingers, rather than in a needle holder, for greater delicacy of touch, is worked through the hilum of the lower lobe close to the mediastinum. This needle passes above the bronchovascular part of the hilum and not between the bronchial and vascular elements. The silk is cut in two, and one half is tied with a surgeon's knot as tightly as possible around the upper part of the hilum and the other half around the lower part and each is then made to surround the hilum and is again tightly tied. Then a new catheter should be tied tightly around the hilum over the silk ligatures so that, through its elasticity, it will progressively squeeze the fibroid hilum and completely occlude the pulmonary artery and vein, should the silk ligatures have failed to do this. A fenestrated air-tight drainage tube is introduced through a stab wound into the bottom of the costophrenic sinus. The old incision in the thoracic wall is closed tightly in two or three layers around a clamped Dakin's tube or catheter, which enters the pleural cavity. Snug dressing. After awakening and before leaving the operating table, the patient is got to cough and expectorate all loose secretions from his mouth and tracheo-bronchial tree. After the patient has been put in bed, the air-tight drainage tube, whose outer end has been temporarily clamped, is connected with an extension tube, whose distal end passes under sterile water in a jar.

"Postoperative Care after Second Stage:

"Postural drainages, carbon dioxide and pantopon are used as after the first stage. Instillations of 60 c.c. of Dakin's solution through the small tube in the incision at two or four hour intervals are begun immediately after operation and continued until the bronchus at the hilum opens. Two or three days after operation the incision is completely reopened and Dakin's or acriflavined packs are placed loosely around the gangrenous lobe and are changed daily; one or two Dakin's tubes are packed in with the gauze for continuation of Dakin's or acriflavine instillations. Should the diseased lobe be found to be at all viable it should be religatured with silk or rubber. It usually falls away within two or three weeks. It may be cut away several centimeters from the hilar ligatures four or five days after operation. To do so sooner, directly exposes the thrombi within the large vessels to a greater danger of infection. During the next two to four months the empyema cavity will practically disappear and the open bronchus may close unaided or after occasional applications of 40% silver nitrate solution. If the bronchus does not close by these means, it may be closed by a pedicled muscle plasty, using the latissimus dorsi from below the original incision."

According to Alexander the gentle wiping of the entire interpleural surface at the first stage causes a traumatic pleuritis with infiltration and marked thickening of the subpleural layer which, presumably, serves as a partial protective barrier against the inevitable interpleural infec-

tion that follows the second stage of the operation performed ten or twelve days later. It is also said to serve as a protection against the development of mediastinitis. In addition the traumatic pleuritis causes the undiseased upper lobe to become firmly adherent to the thoracic parietes during the interval between the first and second stages. This "prevents what would otherwise be a grave total hemithoracic empyema."

Alexander states that each stage of the operation can usually be performed in less than thirty minutes. This, he considers to be a great advantage to patients who have long been ill from a toxic disease. He feels that this period is considerably shorter than that employed in a one stage lobectomy. He also points out that as the bronchus in the technic he has described does not open at all until the mediastinal partition is quite rigid and well protected by infiltrate, that one of the greatest dangers of all noncautery technic is eliminated, namely emphysema or tension pneumothorax if the thoracic wall be closed or mediastinal flutter if it be open.

Alexander has furnished us with the following results. Again we quote from his personal communication:

"Twelve cases of two-stage lobectomy for bronchiectasis. Five (41.66 per cent) are completely cured (no sputum and wound closed); two (16.66 per cent) greatly improved; two (16.66 per cent) improved; one (8.33 per cent) operated on too recently to judge result; none unchanged or worse except two (16.66 per cent) dead. By excluding the too recent case, nine (81.81 per cent) of the eleven are either cured or improved and in eight of them the wound is closed, the remaining one having a pin-sized opening that is sometimes open, sometimes closed. The condition of the two patients listed as 'greatly improved' is: (1) Mother says he is 'perfectly well' and regularly at school; he expectorates three or four times a day; sputum is nonodorous and his wound is healed. Before operation when ten years old, he had had 'pneumonia' five times. (2) Nine-year-old child is active and appears well though delicate; she has infected sinuses and recurrent attacks of otitis media and mastoiditis. She has from 4 to 10 c.c. nonodorous sputum daily, which comes from bronchiectases of her upper lobe, whereas before phrenicectomy she had 100-120 c.c. foul sputum and before lobectomy 50-70 c.c. foul, blood-streaked sputum. The condition of the two patients listed as 'improved' is: (1) Works all day at house work. Sputum 25 to 50 c.c. daily; occasionally blood-streaked. Pin-sized bronchocutaneous fistula is occasionally open. Before operation had from 120 to 140 c.c. sputum. (2) Good general condition but in tuberculosis sanatorium because a few apical tuberculous lesions appeared several months after lobectomy; 20-50 c.c. sputum, occasionally blood-streaked; before operation, 72-120 c.c. and repeated hemoptyses for weeks. Referring to the two deaths: (1) A man died from an unknown cause within 24 hours

after what I now recognize as an injudicious and only partially successful attempt to free the diseased middle lobe from firm adhesions during the first stage operation. (2) Normal postoperative course for three weeks when high fever developed, and an esophago-pleural fistula formed and patient died one month after operation. No necropsy. Probably late mediastinal infection in region of pulmonary lobe stump. There has been no death among the last six patients; these have had the benefit of the operative technic, with occasional slight modifications, which has been described in this communication and which has been developed only after imperfect application of the principles involved in this two-staged total lobectomy upon the first six patients."

Nissen reported the successful removal of the entire left lung for bronchiectasis.

Nissen's patient was a twelve-year-old female, who was originally admitted with signs and symptoms of mediastinal emphysema. The jugulum was incised and the air allowed to escape. The cause of the emphysema was found to be a tear in the left main bronchus. This child developed an empyema, which was drained, and rather soon after signs of chronic suppuration in the left lung. Lipiodol was injected through the sinus of the chest wall and revealed acquired bronchiectasis involving the entire lung. The entire mediastinal contents were displaced markedly to the left. It was found too that the child had a bronchostenosis secondary to the perforation. It was decided to take advantage of this fact and to endeavor to remove the entire lung by allowing it to sequestrate following the ligation of the hilus. Sauerbruch, some years before, had ligated the hilus because of bleeding during the removal of a ganglioneuroma. Ten days later the entire lung sequestrated and the patient got well. Nissen's patient was only in relatively good condition. He resected portions of the third and fourth ribs in the axillary line under ether anesthesia. A phrenicectomy was then performed. Pneumolysis of the entire lung was undertaken but the patient's condition became very poor and so a tampon was introduced and the operation interrupted. Fourteen days later the second stage was performed. The entire lung was freed to the hilus and a very tight rubber silk ligature tied about it. After 14 days the entire lung sloughed away and after 8 weeks only a small bronchial fistula persisted. The heart and soft tissues filled the left pleural cavity so that a plastic operation was unnecessary. At the time of the report the child was in good condition.

Brauer in 1925, stated that total lobectomy was unnecessary and dangerous, and that all that was necessary was to obtain adequate drainage, and that this could be done by a partial resection. This operation calls for the mobilization of the affected lobe. Deep sutures are then placed in order to produce necrosis of the peripheral portion of the lung and at a subsequent date the lung is amputated with use of the paquelin cautery. Denk occasionally treats the remaining lung tissue with the cautery. He has performed the operation on 4 occasions, and in his publication in 1929, states that another patient was being treated in this manner. One of his patients died following the preliminary procedure. Good results were obtained in two. In one case expectoration was reduced from 1000 c.c. to zero, and in another from 250 c.c. to 10 c.c. A complete cure is looked for in the last mentioned case. Three of the

patients still present bronchial fistulas. Denk recommends this procedure.

Harrington in a personal communication states: "I have done no cases of lobectomy for bronchiectasis as a primary operation. However, I have done six cases following partial or complete surgical collapse. All of these cases had a preliminary phrenicotomy. They were all of a multilocular type of abscess. Two cases of this group died following operation, from pneumonia associated with multiple pulmonary hemorrhages from the mouth. One case was found to have a small bronchiectatic abscess in the opposite lung, which had not been diagnosed previous to operation and the hemorrhages may have been from this source. In the four cases that survived operation, one is entirely healed and the other three have small bronchial fistulas. All of these cases had very extensive bronchiectasis involving more than one lobe of the lung, which I believe presents one of the most difficult surgical problems, that is, where the disease is scattered throughout the entire lung."

"It may be that we are too conservative in cases of bronchiectasis confined to one lobe but we feel that conservative measures should be given a thorough trial. Many of these cases receive sufficient symptomatic relief that we do not feel more radical procedures are justified although I believe that in those cases which do not respond to conservative treatment, lobectomy should be considered."

Bettman's results with cautery pneumectomy have already been presented in the section immediately preceding this one. He states in a personal communication that in addition he has had one case in which he tried a one stage lobectomy with death resulting shortly after the operation.

In a personal communication Churchill has presented the following four experiences:

"(1) Male 17. Exteriorization lobectomy preceded by temporary paralysis of the phrenic nerve and lower rib resection. Very little of the lobe sloughed off but the patient has been completely relieved of cough and sputum. A pin point bronchial fistula opened in the wound after six months of complete closure. During the past year he has had two hemorrhages from this fistula. No discharge and absolutely no sputum.

"(2) Male 18. Repeated life endangering hemorrhages from bronchiectasis in the right lower lobe. 2 oz. non-foul sputum. Preliminary phrenicectomy and rib resection. Lobe freed and diseased portion removed by deep stitches and exteriorization. Result: Wound healed completely. No further hemorrhages.

"(3) Male 21. Repeated hemorrhages and constant 3 oz. of sputum from the bronchus of left lower lobe. Preliminary phrenicectomy, single stage lobectomy by primary amputation of the lobe and closure of the stump with deep stitches. Result: No sputum, no bronchial fistula, small empyema cavity which soon became obliterated.

"(4) Male 10. Preliminary crushing of the phrenic. Primary amputation of the lobe as in case (3). Result: 2 drams of sputum a day in contrast to 2 oz. before operation. Still a residual empyema cavity which is rapidly closing."

At the present time Churchill states that he should elect to do a lobectomy by the following procedure:

(1) Temporary crushing of the phrenic. (2) Postural drainage under hospital observation for 6 weeks. (3) Exploratory thoracotomy. If the pleural cavity is found obliterated, then to proceed with amputation of the lobe between tourniquet after the method of Shenstone. If free pleural cavity is encountered separation of the adhesions about the lobe and division of the pulmonary ligament. (4) Secondary operation with amputation of the lobe at a later date.

In a personal communication Flick states that he has performed 3 lobectomies with 2 deaths and 1 complete cure. The type of operation differed in each case. The following abstracts recount his experiences:

"CASE I.—C. H. Jefferson Hospital P 10314. Bronchiectasis left lower lobe. Pulmonary hemorrhages. Pyopneumothorax, left pleural cavity. April 12, 1927—Drainage of pyopneumothorax. Wound healed. Foul expectoration and frequent hemorrhages continued. October 20, 1927—Local and nitrous-oxide anesthesia. Resection 6th, 7th and 8th ribs close to spine. Pleural cavity opened. Adhesions about lower lobe separated except between lower lobe and diaphragm where they were very dense. Operation terminated because of poor condition of patient. Wound closed. October 28, 1927—Local and nitrous-oxide anesthesia. Resection 9th, 10th and 11th ribs. This was done to gain better exposure for subsequent separation of adhesions at base. Pleural cavity not opened. November 10, 1927—Ethylene anesthesia. Thorax opened and adhesions about lower lobe separated. Upper lobe firmly adherent to chest wall and did not collapse. Whittemore type of procedure done. Lobe anchored in wound. Died twelve hours later apparently from shock, although he left the operating table in good condition. Autopsy failed to show any other cause for death."

"CASE II.—E. W., age thirty, Jefferson Hospital 2-8101. Bronchiectasis, right lower lobe. Pulmonary hemorrhages. April 2, 1928—Phrenic neurectomy. May 17, 1929—Nitrous-oxide anesthesia. Subperiosteal resection of 11th, 10th, 9th and 8th ribs through incision ordinarily used in doing lower stage of a paravertebral thoracoplasty. May 29, 1929—Subperiosteal resection of the posterior part of 7th, 6th and 5th ribs through an incision beginning over the erector spinae mass at about the level of the 6th rib and extending downward and forward over the seventh rib to about the mid-axillary line. June 5, 1929—Nitrous-oxide anesthesia. Upper wound reopened and bed of seventh rib incised. Lower lobe freed and pulmonary ligament divided. Lower lobe remained attached only by pedicle made up of bronchus, the vessels and some lymph nodes. This was ligated with two No. 3 chromic gut ligatures and lower lobe cut away. A small hole was made in a piece of rubber dam and the stump of the amputated lobe drawn through this opening and gauze packed loosely around it within the dam, edges of rubber dam brought out and wound partially closed around it. Upper and middle lobes adherent so that there was no marked respiratory embarrassment. Bronchial fistula resulted. December 27, 1929—Bronchial fistula closed and covered with muscle. Patient seen recently. Wound has remained closed and he is entirely free from symptoms. (Case reported in Transactions of Philadelphia Academy of Surgery, Annals of Surgery, Vol. 93, 1931, page 1240.)"

"CASE III.—J. O'D., age thirty-three, Jefferson Hospital. Bronchiectasis right lower lobe. March 6, 1931—Phrenic neurectomy. November 7, 1931—Spinal anesthesia supplemented with nitrous-oxide. Technic advocated by Dr. John Alexander carried out in first stage only. Resection of 6th, 7th and 8th ribs. Pleural cavity

opened. Parietal pleura in upper chest and visceral pleura over upper and middle lobes rubbed with gauze. Adhesions about lower lobe separated. Lung inflated and chest wound closed. Infection of wound developed and delayed second stage. December 14, 1931—Local and nitrous-oxide anesthesia. Chest reopened at site of previous wound. Lower lobe densely adherent and separated with difficulty. Pedicle ligated with ligatures of No. 2 chromic gut and lobe cut away. Tube with fenestrations introduced in pleural cavity and brought out through lower angle of wound. Wound closed tightly about it. Given blood transfusion and placed in oxygen tent. Continuous suction was made on catheter in pleural cavity by means of electric pump maintaining negative pressure of 7 cm. of water. Patient did well until December 26 when he had a chill and temperature rose to 104. On January 2, 1932, Weakness of left arm, later hemiplegia. On January 5, 1932, right cortical abscess drained under local anesthesia. January 9th, death from abscess of brain. Chest condition had remained satisfactory."

Dolley has performed a successful two-stage lobectomy according to the method described by Whittemore. The patient is said to be in excellent condition.

As one might expect, a vast majority of the successful lobectomies for bronchiectasis have been performed upon children and young adults. The recorded cases definitely illustrate that lobectomy can be a most satisfactory procedure. They also indicate that it is possible to obtain good results by either single or multiple stage operations. The former are not always feasible. It must be admitted, however, that lobectomy is still attended by a considerable operative mortality. We are not convinced that all the lobectomies performed up to the present time have been undertaken in the presence of the severe forms of bronchiectasis. It would seem quite obvious too, that it is possible to perform only what amounts to a subtotal lobectomy on some occasions. Many lobectomies have been performed in the presence of congenital bronchiectasis. And there is still considerable doubt in the minds of some as to whether congenital bronchiectasis should always be treated by lobectomy. Again, many of the results are early and one must await the elapse of several years before being convinced that what is now reported as a definite improvement may not later be considered as an unsatisfactory result. For it is usually wiser to consider that anything but a clinical cure following a lobectomy implies that dilatations and diseased parenchyma still persist. There can be no doubt, however, that lobectomy is theoretically an ideal procedure and that it is certainly indicated in some forms of bronchiectasis. On the other hand there are other types which do not seem suitable for this operation. Those which present indications for cautery pneumectomy have already been discussed under the appropriate heading. There are perhaps still other types in which no radical surgery is indicated. (See discussion under "The Fate of the Individual with Untreated or Inadequately Treated Bronchiectasis."). In this connection it is to be hoped that future reports will consider the clinical history and type of bronchiectasis present in the given

case in more detail. Unfortunately, the type of operation frequently makes the demonstration of a specimen impossible because the lung is allowed to become gangrenous and sloughs away.

Up to the present time lobectomy has very little to offer to patients with extensive bilateral bronchiectasis. One case of bilateral cautery pneumectomy has been reported and we are told that Eloesser has performed a successful bilateral lobectomy for bronchiectasis.

In summarizing this discussion on lobectomy for bronchiectasis, one can only say that although improvements in methods of operating have been introduced in recent years, nevertheless the operation remains even in the best hands one of the most serious procedures in the surgical repertory. From a list of collected operations performed by different operators and by different methods it is hardly fair to draw precise conclusions concerning the operative mortality and the probable chance of a satisfactory result. Yet the fact remains that in 212 collected cases no less than 72 patients (34 per cent) have died apparently because of the operation and apparently in only 99 patients (47 per cent) was a thoroughly satisfactory result obtained. Even if we take only the more recent and the more favorable figures we still find that a patient with bronchiectasis who submits to a lobectomy runs about a 15 to 20 per cent risk of dying because of the operation, and that if he recovers from the operation he has only about a 65 per cent chance of having a thoroughly satisfactory result with solid healing of the wound. In presenting this aspect of the results of lobectomy, there is no intention to be destructive or to argue that the operation is too dangerous or too uncertain in its results to be justifiable. On the contrary, much satisfaction should be gained from the fact that so many patients with this terrible disease have been made well. For probably most of those who have obtained satisfactory results have been saved from death due to the natural consequences of the disease; and most of those who have died as a result of the operation would have died if left untreated.

THE FATE OF THE INDIVIDUAL WITH UNTREATED OR INADEQUATELY TREATED BRONCHIECTASIS

One important phase of any discussion on bronchiectasis is the question of what may happen to any individual with this disease who has no treatment or inadequate treatment. There is very little definite information available on this question at the present time. One finds many statements that it is a progressive disease, but practically no evidence has been given on which to support such an assertion. We have seen cases that convince us that some types are progressive and others not. Practically no attempts have been made to classify bronchiectasis on this basis, yet it is of the greatest importance for thoracic surgeons to be able to do this if possible before advising a radical operation which.

with present methods, must be regarded as a dangerous one. If, in the future, it is possible to tell that certain cases or certain types will probably not be progressive, then exceptionally dangerous radical operations will not be advised for such cases. It was hoped that the previous classification, based upon bronchoscopic lipiodol injections, would permit one to differentiate between the favorable and unfavorable types. Our observations have not been sufficient in number to warrant conclusions which are entirely satisfactory. We are, however, presenting here certain facts which have come to our notice as the result of focusing attention on these questions.

We shall consider first the fate of the child and then of the adult with untreated or inadequately treated bronchiectasis. Can bronchiectasis which has been demonstrated by lipiodol and which is associated with definite signs and symptoms disappear? Up to the present time it does not seem that such is the case very often. More important, however, is the fact that at the present time we have no right to state that the lesion need progress in every case. Is it not striking that saccular dilatations of the congenital variety are frequently first observed in adults or middle-aged individuals? This implies that bronchial dilatations may be present for many years without attracting attention clinically. The disproportion between the signs and symptoms and the dilatations in such cases may be striking.

It is also a fact that we frequently observe advanced bronchiectasis of the acquired type in young children. Bronchiectasis may develop very rapidly. We have seen it develop in less than three months in an infant who had aspirated a peanut (Fig. 34).

We do not believe that the duration of the disease influences the prognosis in every case or that the age at which the dilatation develops is always significant.

In children with cystic disease of the lung there is often an associated condition of bronchiectasis entirely apart from the cysts. When the cysts are large then the bronchiectasis present is usually of the acquired type. The outcome in such cases is frequently unfavorable even though the cysts fail to rupture or become infected. For the bronchiectasis in such cases is usually associated with considerable pulmonary fibrosis, with chronic pneumonia and abscess formation. On the other hand, the outcome of congenital saccular bronchiectasis, called by some authors cystic bronchiectasis, seems not nearly so unfavorable, although we still require more information about such cases.

Some cases of foreign body bronchiectasis in children may have a favorable outcome if the foreign body is removed early; but if it has been allowed to remain until irreparable damage has been done to the lung then the outcome, even after the withdrawal of the foreign body may be most unfavorable. In some a foreign body may remain for

years without producing bronchiectasis while in others a similar one may result in severe bronchiectasis within a short time.

We frequently observe bilateral bronchiectasis in children who are free from fever and in whom the dilatations are apparently due to an unresolved pneumonia. The dilatations are not very marked and it would seem as if the outcome in many such cases is good. Just why some children develop bronchiectasis following the bronchopneumonia of the exanthemata we do not know.

Some children may carry dry bronchial dilatations for years as the following case illustrates.

CASE 19.—L. A., female, aged thirteen, was first observed in 1927, at St. Louis Children's Hospital, when she had as her chief complaint cough of 10 years' duration. Her past history noted an operation for fistula in ano, which may have been tuberculous, chronic otitis media at the age of 3, pertussis at the age of 5, chicken pox and mumps at the age of 7 and the bronchopneumonia of measles at 9, and another attack of pneumonia at the age of 11. The onset of her condition was insidious. Two years previous to her admission to the hospital her cough became associated with some sharp pain in the right chest and with some bloody expectoration.

Physical examination revealed bilateral chronic otitis media and an acute infection involving the upper respiratory tract. The physical examination of the chest was essentially negative. Roentgen-ray examination of the chest revealed mediastinal thickening and a dense shadow at the right base extending from behind the heart shadow. The lipiodol injection revealed definite bronchiectasis of the acquired type at the right base. Her sputum was free from acidfast bacilli. The tuberculin test was mildly positive. She was sent to Ridge Farm where she remained for almost 9 months. She was readmitted to the St. Louis Children's Hospital on August, 1928, when she was found to be suffering from diphtheria. She was free from cough and expectoration and her bronchial dilatations were dry. A lipiodol injection on May 13, 1929, again demonstrated that the dilatations were still present, and she has been observed recently and is still free from complaints referable to the lower lobe of her right lung. Just how long this condition will continue to be asymptomatic is uncertain.

Experiences have also indicated that an operation may relieve a patient of severe symptoms for years and yet striking dilatations may still be present.

If the trachea is in the midline and there is little or no fever and no atelectasis then the outcome is not nearly as bad as when the dilatations are associated with atelectasis and when there is fever. We are more often concerned with the parenchymal and peribronchial changes than we are with the dilatations.

We have frequently examined children whose roentgen-ray films suggest extensive bronchiectasis. They have considerable fever and cyanosis, the latter in some instances being so severe as to suggest enterogenous cyanosis. A lipiodol injection in such a case may fail to reveal the presence of dilatations. One of us (H. C. B.) has had the opportunity of examining such lungs at necropsy and has been impressed with the degree of sclerosis in the terminal branches of the pulmonary artery and

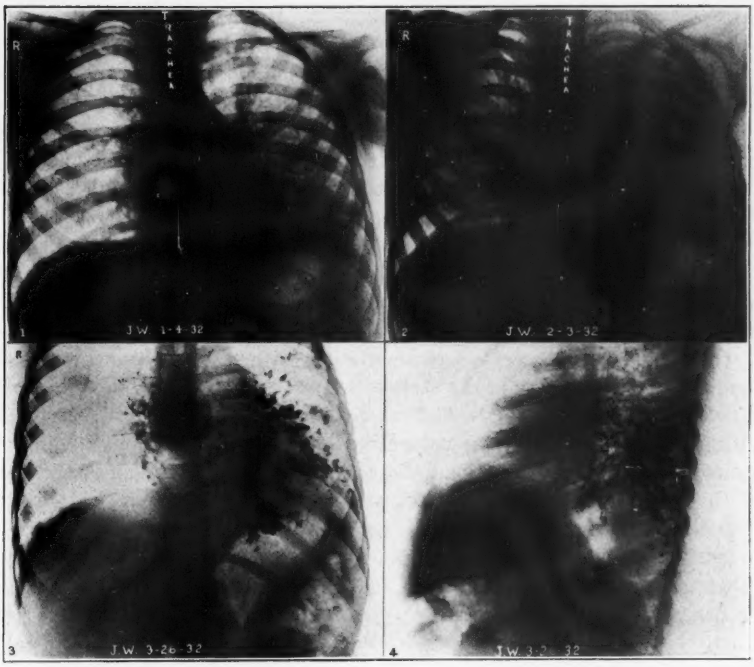

Fig. 34.—Bronchiectasis due to foreign body. The above films illustrate how quickly bronchiectasis may develop.

J. W., female, aged three, was admitted to the St. Louis Children's Hospital on January 1, 1932. Her complaints were cough, high fever and headache of less than a week's duration. Several other members of the family were suffering from influenza at the time. Physical findings on admission were referable to the left chest and the child was considered to be suffering from pneumonia. She was placed in an oxygen tent. Throughout this period she ran a septic temperature. The roentgen-ray appearance of her chest on January 14, 1932, is noted in Fig. *1*. There is increased detail at the left hilus extending to the base. On January 14, the physical findings suggested fluid in the left pleural cavity. About 1 c.c. of thick pus was obtained on aspiration. This pus did not contain any organisms. Following this puncture one could observe a pneumothorax pocket at the left base. It was never possible to determine whether it was spontaneous or artificial. At this time it was considered that the child was in all probability suffering from one of the consequences of an unresolved pneumonia, namely multiple abscesses. There were some, however, who considered that the chief lesion was an empyema. A film taken on February 3 (see Fig. *2*) revealed massive atelectasis involving the entire left lung. Bronchoscopic examination was recommended because it was felt that the bronchus was in all probability obstructed by mucus and pus. The history had been originally obtained from the child's father because the mother was ill at home with influenza as already noted. However, on February 8, the mother came to the hospital and stated that six days previous to admission to the hospital the child had been seized by "violent spasms" and had become very blue. It seemed likely that she had choked on some peanut candy which she was holding in her hand. The child was bronchoscoped on the following day and a peanut was removed from the left main bronchus. Because of extreme edema of the glottis and larynx and the presence of considerable pus in the tracheobronchial tract it was necessary to do a tracheotomy on February 9. Since then the child has been bronchoscoped at intervals and secretions aspirated. A lipiodol injection performed on February 24, demonstrated the presence of extensive bronchiectasis. The lesion was then similar to that which can be observed in (*3*) the film taken on March 26. The lateral view (*4*) on March 26, shows that the bronchiectasis is undoubtedly of the atelectatic type. This child is still receiving bronchoscopic treatments, her temperature is practically normal, the atelectasis has cleared up considerably, but she will probably always have dilated bronchi. In the absence of a lipiodol film before admission one cannot be absolutely certain that the dilatations were not present before the aspiration of the foreign body, but this possibility seems unlikely.

The above case indicates how serious may be the consequences if one neglects to consider the possibility of a foreign body early in every case of unexplained pulmonary suppuration in a child.

with the numerous peribronchial abscesses present. The outlook in such cases is very grave. The etiology is frequently the bronchopneumonia of the exanthemata and of pertussis.

McCordock has recently demonstrated the presence of intranuclear inclusion bodies in the lungs in pertussis. These may prove to be of great significance in the etiology of this type of interstitial pneumonia. McCordock believes that the interstitial bronchopneumonia in such cases is primarily due to a filtrable virus with secondary bacterial infection. It is believed that the destruction of the bronchial wall in these cases predisposes to development of bronchiectasis. Such changes are not observed in the ordinary bronchopneumonias in which bacteria alone are concerned.

One occasionally observes a child or adult with saccular bronchiectasis and with bronchiectasis of the atelectatic type in the opposite lower lobe. There can be little doubt that the manifestations of sepsis are then due to the acquired bronchiectasis since it is usually easy for the patient to empty the saccular dilatations. It is also easy to fill such dilatations with lipiodol. In addition, the sum total of diameters of such dilatations usually indicates that there can be little pulmonary parenchyma in such a lung and consequently little room for parenchymal involvement—for pneumonia and abscess formation.

Perhaps the most unfavorable type of bronchiectasis in the child is that which is clearly manifested by the displacement of the mediastinal contents to the affected side. Those types of bronchiectasis in children which are associated with much fibrosis and with progressive displacement of the mediastinal contents to the affected side usually end fatally within a few years. They are frequently due to a foreign body. The production of a roentgen-ray picture similar to what would be considered as ideal for thoracoplasty, were the condition one of pulmonary tuberculosis in an adult, is in a child with bronchiectasis most unfavorable. Such a child, if untreated, will die from pneumonia or multiple lung abscesses or both. (Fig. 35.)

Many children with conditions similar to the one referred to in Fig. 35 are erroneously treated for unresolved pneumonia. Unresolved pneumonia of several months' duration in a child usually implies empyema, multiple abscesses, bronchiectasis, or both of the latter. The course is unusually down hill when the trachea and mediastinal contents begin to be displaced to the affected side. These experiences coincide in general with those of L. Findlay and Stanley Graham. They believe that "the prognosis in bronchiectasis in childhood is grave as the condition usually steadily gets worse and leads to a fatal termination." There is not sufficient evidence at present, however, to warrant the conclusion that all types of bronchiectasis in children "steadily get worse." This is true of the type just described, but it may not be true of other types. A midline trachea and the absence of visible dilatations does not permit

one to conclude that the changes in the parenchyma are not striking or that they will not progress. In attempting to make observations as to the progress of the disease, purely on the basis of lipiodol injections, one must realize that it is important to have good control films. This implies that both lungs should be injected when the child first comes under observation, for it is striking that frequently the physical signs and ordinary roentgen-ray findings may be least marked on the most diseased side. Particularly is this the case if the dilatations are hidden behind the heart shadow. And, in this connection, it is well to remember that mediastinal thickening and dextrocardia in a child should always suggest the possibility of bronchiectasis. In children with mild bronchiectasis and definite sinusitis the early treatment of the latter may accomplish much and may prevent the development of inveterate bronchorrhea.

We do not wish to imply that it is always possible to separate out the various types of bronchiectasis in the manner indicated above. It would likewise be unwise to conclude that the outcome suggested is always the same in any given type of case.

What has been said about bronchiectasis in the child also holds true for bronchiectasis in the adult. It is frequently impossible to prognosticate just how long a patient with a given type of bronchiectasis will live if untreated. Certainly there are cases in which the duration of the disease in severe cases has been known to exceed well over 15 years. In the case of acquired bronchiectasis in the adult it is important to differentiate between those types due to lesions within the bronchus and those secondary to parenchymal changes. The former are usually manifested by cough and expectoration and rarely by fever and chills, and in such cases lipiodol injections usually reveal dilatations which extend well to the periphery. There is no displacement of mediastinal contents and no atelectasis.

In the presence of monolobar saccular dilatations in the adult it is always well to exclude the presence of acquired dilatations in the other lobe. The fact that the saccular dilatations can be readily injected usually causes one to disregard the above mentioned possibility and one's attention is directed to those dilatations which are most obvious.

Many adults with bronchiectasis have as their only complaint hemoptysis. Many such patients are erroneously treated as tuberculous suspects. It is well to remember that this form of dry bronchiectasis may persist for many years and that hemoptysis may be the only symptom produced. It is not unlikely that early in the development of these dilatations there may have been cough and expectoration.

One not infrequently observes what clinically appears to be severe bronchiectasis without gross evidence of dilatations or of abscess formation. The outlook in such cases is grave if the lesion is bilateral, since it is usually one of multiple peribronchial abscesses. The roentgen-ray

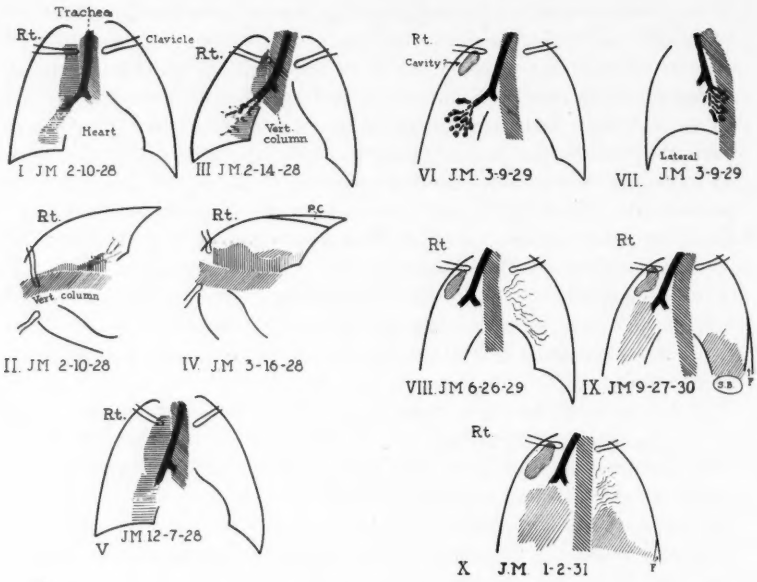

Fig. 35.—The above figures have been reproduced from roentgen ray films. They illustrate one possibility in the case of a patient with a given type of untreated or inadequately treated bronchiectasis:

J. M., *male, age three and one-half,* was first admitted to the Saint Louis Children's Hospital on February 9, 1928. He apparently enjoyed good health until 1927, when he had an attack of measles which was followed by bronchopneumonia. He was confined to bed for three weeks at this time. In November, 1927, he had what was called whooping cough, but shortly after this coughed up a small bur the size of a pea. His mother believes that this foreign body could very well have been aspirated when the child was about fifteen months old because she had noticed a rattling in his chest ever since. Cough and foul expectoration were only noticed for a short period previous to the expectoration of the bur, but during November, 1927, he began to have fever and expectorated foul sputum. On admission to the Saint Louis Children's Hospital he was found to be in moderately good condition. He had a nasal discharge, his tonsils were moderately enlarged and injected. The anterior and posterior cervical glands were enlarged. His fingers showed slight clubbing, his chest was somewhat barrel-shaped. There was limitation of expansion on the right side, and here there were dulness, high pitched tubular breath sounds and many râles. The heart was apparently normal, the liver and spleen were not enlarged, the reflexes normal. A fluoroscopic examination revealed limitation of the movement of the right diaphragm.

Fig. I (2-10-28) shows a midline trachea with increased detail at the right base. The right paramediastinal shadow, considered at one time to be either an enlarged thymus or an atelectatic upper lobe, is in all probability the superior vena cava.

The patient's leucocyte count at this time was 6,800. The intradermal tuberculin test was negative. His sputum was free from tubercle bacilli at all times and repeated bronchoscopic examinations excluded the presence of any retained foreign body. His nasal sinuses at this time were quite free.

Fig. II (2-10-28) taken with the affected side uppermost shows the relationship of the density of the right base to the mediastinal pleura more definitely. This association is also quite definite in the upright film taken on *(III) 2-14-28.*

Under nitrous oxide anesthesia, 150 c.c. of air were injected into the right pleural cavity on March 16, *(IV 3-16-28),* (P.c. = Pneumothorax cavity). This pneumothorax was not followed by any reaction, but subsequent attempts to introduce air into the right pleural cavity proved unsuccessful. The patient was discharged on February 9, 1928, slightly improved.

Second admission on January 17, 1929, (age four years). The patient enjoyed moderately good health until one week previous to this when he developed a high fever. The roentgen ray findings at this time were as indicated in *Fig. V, 12-7-28.* Clubbing of the fingers was slightly more marked, the physical signs likewise. The right ear drum was found to be bulging. A paracentesis was therefore performed and a moderate amount of pus obtained. Shortly after this the physical signs at the right base suggested fluid, but an aspiration resulted in a dry tap. During the latter part of January, 1929, the clinical picture clearly indicated that the entire right lung was becoming involved. A bronchoscopic examination was performed by Dr. Arbuckle

picture of the lung in such cases usually discloses considerable lymphangitis.

Bronchiectasis in the adult is rather exceptionally associated with extreme displacement of the mediastinal contents (see Fig. 36). When present, however, then the possibility of a bronchial stenosis or of tuberculosis must be excluded.

Adults with upper respiratory infection and with mild bronchiectasis do well when the former is treated, because the cough and expectoration in such instances are chiefly due to the upper respiratory infection.

Complications

We have considered in detail the pulmonary consequences of bronchiectasis, stressing in particular abscess formation. Before considering what one may accomplish by treating conditions which are known to act as predispositions let us consider three other complications. These are (1) empyema thoracis, (2) amyloid disease and (3) brain abscess.

Empyema Thoracis.—Empyema thoracis is not an infrequent complication. The empyema is usually an encysted one and most patients are first observed when the lesion is chronic. When the empyema is associated with mild bronchiectasis then drainage of the former may effect a symptomatic cure. The first procedure should always be the treatment of the empyema, but in not a few instances it is desirable to treat the bronchiectasis as well. A chronic empyema which is associated with cough and foul expectoration, even in the absence of a bronchial fistula, should arouse one's suspicion as to the possibility of a lung abscess, bronchiectasis, or tuberculosis.

Amyloid Disease.—Amyloid disease is a serious late complication occurring years after the onset of the bronchiectasis. It is related to the bronchiectasis only because of long continued suppuration and in

on March 1, 1929, pus was then found to be coming from the right middle and lower lobes. Bronchoscopic treatments were continued but they were not accompanied by any improvement. A lipiodol injection *(Fig. VI, 3-9-29)*, revealed definite bronchiectasis at the right base. The presence of a cavity was also suggested in the right upper lobe. Most striking of all, however, was the fact that the trachea was beginning to be pulled over into the right chest. It was now difficult to visualize the right diaphragm. The lateral view *(Fig. VII, 3-9-29)*, shows that the dilatations extended well posteriorly (paravertebral atelectasis with bronchiectasis). The patient was discharged on March 18, 1929, and was *readmitted for the third time, acutely ill, on September 27, 1930.* His sputum was now occasionally blood streaked, shortness of breath was now a new and striking feature. The patient had an apical systolic murmur. Another roentgen ray examination of the nasal sinuses still showed no obvious lesion. He improved on rest in bed and was discharged on October 8, 1930. Note the pulling over of the trachea, *(Fig. VIII, 6-26-29)*, also the development of increased detail in the left lung, at first starting out from the hilus, the latter *(Fig. IX, 9-27-30)*, being most marked at the left base where the presence of fluid (F) was suggested. (S.B. = stomach bubble.) He was admitted for the *fourth and last time on January 30, 1931, when he was six years of age.* One month previous to this admission the patient suffered another acute upper respiratory infection and all his symptoms became more marked. For two weeks previous to his last admission his cough was nonproductive and his fever extremely high, he then began to raise extremely foul, greenish-yellow, purulent sputum. Even during this period of profuse expectoration his temperature ranged from 103° to 104°, dyspnea and cough became so marked as to necessitate the use of an oxygen tent. The sputum gradually became very thick and was expectorated with difficulty. The patient died on January 21, 1931. The roentgen ray appearance of his chest just previous to death was similar to that noted in *Fig. X, taken on 1-2-31.* The nature of the underlying lesion in this case has been referred to in detail in the text.

this respect is no different from the amyloid disease which is known to follow chronic suppuration in other organs. Among other things, the presence of much albumen in the urine and a palpable liver are suggestive. When there is generalized amyloidosis then the anemia and cachexia are usually marked. It is important to recognize the presence of amyloid disease because usually it serves as a contraindication to the performance of any radical operation. Bennhold's Congo-red test is apparently a specific clinical test for amyloidosis. To use this test one injects 10 c.c. of a 1 per cent solution or 15 c.c. of a 0.75 per cent solution intravenously, samples of blood are withdrawn 4 and 60 minutes after. The content of dye in the serum is determined with a colorimeter. It has been found that in the average normal individual 19 per cent of the dye disappeared during the first hour. Forty to 100 per cent of the dye was found to have disappeared in one hour in cases of amyloidosis but only in such cases provided there were extensive deposits of amyloid in the body, particularly in the liver (cited by Barker and Snell). One cannot hope to improve the amyloidosis unless one treats the cause, but unfortunately this accomplishes little in the advanced cases since not only the kidneys but also the liver, spleen, heart and lungs may be involved when the condition is universal. The changes in the lung are usually most marked in the alveolar walls.

The following case is recorded because it clearly indicates that the prognosis should be guarded when amyloid disease is evident:

CASE 20.—No. 32212, male, aged forty, was admitted to Barnes Hospital on November 17, 1931, complaining of cough, foul expectoration, weakness, dyspnea, nocturia and nausea. The respiratory complaints were of 12 years' duration.

Physical examination at first suggested that the patient was suffering from a chronic empyema. The lesion was entirely confined to the right lung. Because of his extremely nervous condition and failure to cooperate, three lipiodol injections were unsuccessful. His liver was palpable, his urine contained considerable albumin but no red blood cells or casts. His blood nonprotein nitrogen was 28 mgms. per 100 c.c. on November 18, 1931. The excretion of phenolsulphonephthalein in his urine was 35 per cent in two hours. In spite of the patient's rather poor condition it was considered that the only wise thing to do would be to subject him to an operation which would have as its only objective the establishment of drainage. This was accordingly done (E. A. G.) on November 28, 1931. The fifth and sixth ribs, (right) were resected in the posterior axillary line. The pleura was found to be greatly thickened. When it was incised with the actual cautery, one then came upon a large abscess cavity in the lung which appeared to communicate with a similar cavity. Not as much pus as one might have expected was obtained but this was probably due to the fact that the patient had coughed up several hundred c.c. of pus just previously to operation. Tube drainage was instituted and the patient left the operating room in rather good condition. He received large amounts of glucose intravenously, but within a few days after operation he began to develop generalized edema. His blood nonprotein nitrogen had risen to 100 by December 3, 1931. The patient vomited frequently during this period, voided little urine and died from uremia. Necropsy was performed on January 1, 1932, by Dr. J. E. Smadel. The gross findings were bronchiectasis with multiple

abscess formation and pneumonitis; amyloid degeneration of the liver and kidney and thrombosis of renal veins with calcification (Fig. 36).

Brain Abscess as a Complication of Bronchiectasis and Pulmonary Suppuration.—The association of abscess of the brain and pulmonary disease has long been known, but it is still difficult to explain the mechanism responsible for it. That the infection occurs in the respiratory tract and brain simultaneously is of course possible, but what is more likely, is that the brain abscess is a metastasis from the pulmonary condition.

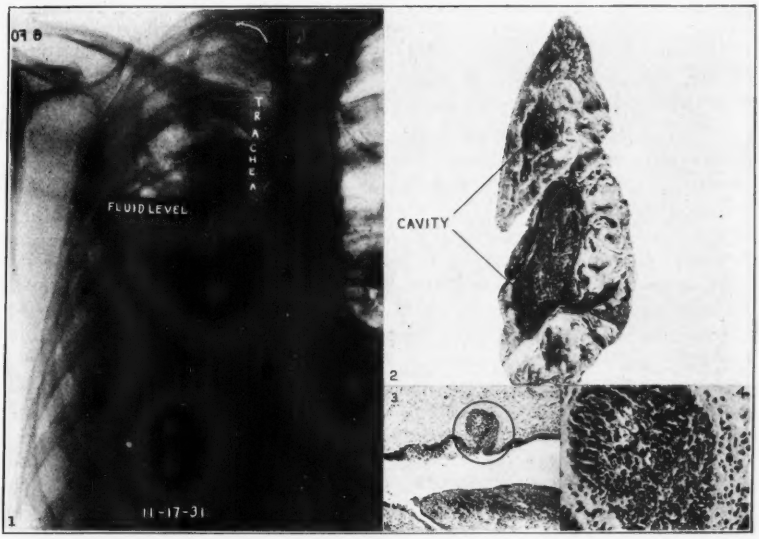

Fig. 36.—Bronchiectasis and amyloid disease: (Case 20.) Fig. *1*. This patient suffered from bronchiectasis of twelve years' duration and previous to his operation presented definite evidence of generalized amyloidosis. An attempt to improve this condition by the establishment of drainage of the abscess cavities precipitated a fatal attack of uremia. Note the displacement of the trachea to the affected side and the fluid level. It is impossible to visualize the right diaphragm. This picture is rather atypical for bronchiectasis.

Fig. *2*, represents the right lung in this case. Note the two large cavities. These communicate directly with bronchi. Note also the extremely dilated and sclerotic bronchi. The visceral pleura which is not visible was over 0.5 cm. thick. The abscess cavities were in places lined by bronchial mucous membrane. Many of the dilated bronchi contained metaplastic buds similar to those noted in Figs. *3* and *4* (low and high power magnifications).

The theory of ordinary embolism has always seemed attractive because of the theoretical ease with which a clot could pass from the lung through the pulmonary vein into the left heart and from there through the carotid artery to the brain. In this respect pulmonary infections in general would seem to offer better opportunities for giving rise to cerebral abscesses than infections in other organs would, because in the latter instances infected thrombi would become lodged in the lungs or liver. There are, however, several objections to the acceptance of this

theory. For example, there is no apparent reason why infected emboli from a focus of suppuration in the lung should not pass to other organs as well as to the brain, since they must enter the aorta before entering the carotid artery. Yet abscesses in the brain are common and abscesses in other organs are very rare as a complication of bronchiectasis. Moreover in general pyemia, abscess of the brain is rare even when abscesses are present in the lungs.

McCordock feels that there is no good evidence that the cerebral abscess which follows bronchiectasis is due merely to the transfer of infected emboli. He states that the only essential respect in which embolism associated with chronic suppurative conditions of the lungs differs from those found in cases of general pyemia is in the type of microorganism concerned in each group.

We have collected (Table XI) some of the cases recorded in the literature and 4 observed at Barnes Hospital and at the City Isolation Hospital, the latter to be recorded in detail by McCordock elsewhere. In the 4 cases studied by him, bronchiectasis was the constant finding. On 3 occasions this lesion was associated with lung abscesses or chronic empyema, while the basic disease in the fourth case was pulmonary tuberculosis. "A routine bacteriologic examination of the pus of the brain abscesses in 3 instances failed to show any cultivatable bacteria; but a staphylococcus was found in the fourth. Material scraped from the wall of the abscesses in one instance revealed loosely coiled spirochetes under dark field illumination. Sections of the brain tissue stained by Levaditi's method showed on two occasions tangled masses of coarse, loosely coiled spirochetes in the layer of tissue lining the abscesses but no other bacteria. Numerous spirochetes and fusiform bacilli were found in the walls of the abscesses but not in the pus that filled the abscess cavities. The fourth case, the one from which staphylococci were grown, revealed spirochetes in the abscess wall, and cocci and bacilli in great numbers among the pus cells forming the central zone of the abscess. The type of spirochetes found in these abscesses was similar to those found in the walls of the dilated bronchi and in the abscesses in the lungs of these patients (McCordock)." (Fig. 37.) These findings in considerable measure corroborate the work of D. T. Smith on experimental bronchiectasis. It should be noted that fusiform bacilli have been found in brain abscesses by A. Ghon and others, but that a review of the literature up to the present time has failed to reveal any recorded cases of brain abscess caused by spirochetes similar to those found by McCordock, who suggests that the unique bacteriologic flora of bronchiectasis is an important factor in the production of brain abscess in these cases. It has also been suggested that the spirochetes are probably carried to the other viscera also, but that they apparently die out in these organs although finding conditions favorable for growth in the nervous tissue.

Adam's suggestion that brain abscesses result from nasal sinus infections which are so frequently present in patients with bronchiectasis hardly seems likely.

An analysis of recorded cases does not reveal anything materially new or in any way typical with regard to the diagnosis of cerebral abscess in the type of case which we are considering. The abscesses approach more the acute than the chronic type, but occasionally there is evidence of considerable latency. The abscesses may be encapsulated, they are frequently multiple but may be solitary. Single abscesses were present in 18 cases collected by Schorstein, more than 1 in 7. The signs and

TABLE XI

THE ASSOCIATION OF BRAIN ABSCESS AND BRONCHIAL, PULMONARY AND PLEURAL SUPPURATION

AUTHOR REFERENCE	NUMBER OF CASES	NATURE OF PULMONARY LESION	REMARKS
Powell, R. (1815): cited by S. Barling: Lancet: **1**: 121, 1925.	1	Empyema and Bronchiectasis	Did not associate pulmonary brain lesions
Cayley, W.: Transactions of Pathological Society, London: **35**: 12, 1884.	1	Bronchiectasis	
Findley, D. W.: Lancet: **1**: 298, 1886.	1	Empyema	
Clayton, T. A.: Phila. Med. Jour.: **7**: 437, 1901 (collected cases).	58	Bronchiectasis 20 (34%)	Gunshot wound of the lung, and pneumonia each 2 (3%): Lung abscess 3 (5%): Tuberculosis 5 (8%): Gangrene 7 (12%): Empyema 10 (17%): Purulent bronchitis 9 (15%).
Schorstein Lecture: Lancet: **2**: 843, Sept. 18, 1909.	69	Bronchiectasis 38 (55%)	Fetid bronchitis and tubercle 1: Emphysema and bronchitis 1: Empyema 15 (22%): Gangrene 6 (9%): Tubercle, acute pneumonia each 3: Abscess of Lung 2.
Ghon. A., u. V. Mucha: Cent. f. Bact.: 1909: 1 Abt. XLIX: H. 4: 493.	1	Pulmonary tuberculosis	First reference to brain abscess caused by fusiform bacilli in association with lung disease.
Dick, G. F., and L. A. Emge: Trans. of Chicago Pathological Soc.: **9**: 95, 1913-1915.	1	Chronic bronchitis	
Roulland, Henri: Paris Chirurg.: **9**: 613, 1917.	1	Empyema	Brain abscess cured by drainage.
Gordon, A.: Med. J. & Rec. **129**: 694, June, 1929.	1	Bronchiectasis	
Romano, N., E. Eyherabide and A. Bianchi: Prensa Med. Argent.: **16**: 1649, May, 1930.	1	Bronchiectasis	
Parker, H. L.: Amer. Jour. of Med. Sciences: N. S. **180**: 699, 1930.	14	Lung suppuration	Author intentionally avoided classifying cases (for reasons see remarks in his text).
McCordock, H.: To be published proceedings Am. Ass'n. Pathologists and Bacteriologists. Am. J. Path. **8**: 1932.	4	Bronchiectasis 4 (one with tuberculosis).	

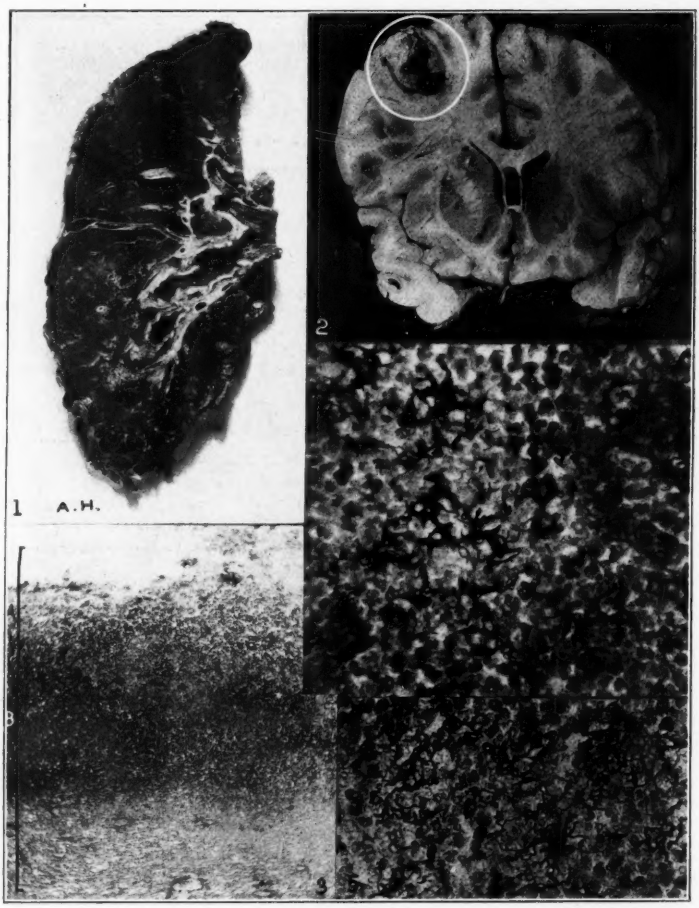

Fig. 37.—Brain abscess and bronchiectasis (Courtesy Dr. Howard McCordock): A. F. H., No. 31334, male, aged twenty-seven, patient of Dr. L. Behrens, was admitted to Barnes Hospital September 15, 1931. His complaints were fever and pain in the left chest, both of three weeks' duration. His past history made mention of a severe attack of influenza during 1918, when he was sixteen. The onset of his present illness was acute. Cough and particularly expectoration were negligible at the start but later he raised greenish purulent sputum, the latter free from tubercle bacilli. The physical and roentgen ray findings were suggestive of a left-sided pleural effusion, but attempts to aspirate his left pleural cavity on September 15 and 16 proved unsuccessful. This prompts one to raise the question as to whether these aspirations may have had anything to do with the brain complication in this case. It was possible to obtain some foul pus from the left pleural cavity on September 17. This pus on direct smear revealed a variety of organisms including fusiform bacilli. Hemolytic streptococci were recovered on aerobic and anaerobic culture. The patient was subjected to a rib resection (E. A. G.) on September 23 when 15 c.c. of very foul pus were obtained. Tube drainage was instituted. Pleural tissue removed for biopsy revealed chronic pleuritis. The patient's early postoperative course was uneventful save for the fact that he suffered from retention of urine. On the fourteenth postoperative day he developed moderate rigidity of the neck, left facial weakness, deviation of the tongue to the left, and questionably positive Babinski, Gordon and Oppenheim reflexes, his fundi were normal, there was no headache or vomiting. It was Dr. S. Schwab's opinion that the patient was suffering from multiple brain abscesses. On the following day the patient experienced great weakness and clumsiness in the movements of the left upper extremity and slight weakness of the left lower extremity. His left palpebral fissure was larger than the right, there was a relative

symptoms include headache, vomiting, paralysis, pupillary phenomena, optic neuritis and changes in the deep and superficial reflexes. These, according to Schorstein, in no way differ perceptibly from those of the general run of cerebral abscess. We do not know of any successfully treated brain abscesses which are associated with bronchiectasis. There have been two successful cases secondary to lung abscesses. Whether a complete neurologic examination in the absence of any outwardly suggestive neurologic signs or symptoms might prove of value in cases of chronic lung suppuration we do not know.

PROPHYLAXIS

Throughout the text reference has been made to those conditions which are known to predispose to the development of bronchiectasis. And from what has been said it becomes obvious that we are more concerned with the condition in children and young adults than we are in older people. The bronchopneumonias of pertussis and the exanthemata should be treated with respect, and great care should be exercised during the period of convalescence. Catarrhal lesions of the upper and lower respiratory tracts should be prevented from becoming chronic whenever possible. Respiratory conditions associated with profuse expectoration should, in the absence of any contraindications, be treated by postural drainage. In the past attention has been directed to the treatment of the upper respiratory tract only after bronchiectasis has become definitely established. We have no right to assume that the treatment of nasal sinus infection in the absence of bronchiectasis will prevent the subsequent development of bronchial dilatations. It should be remembered too, that untreated lung abscesses are known to become associated with bronchiectasis. Perhaps some of those measures which are now being employed to combat the development of postoperative pulmonary complications such as atelectasis may diminish the frequency of bronchiectasis slightly. It is true that the early correction of such known bronchial factors as foreign bodies and strictures can avoid the occurrence of the disease. *Up to the present time it must be admitted, however, that there is no prophylactic measure which carries with it any assurance that its employment will avoid the development of bronchiectasis.*

We are indebted to Prof. Bernhard Fischer-Wasels, Director of Pathological Institute, University of Frankfort, Germany, for permission to include certain material in the discussion of the pathology of bronchiectasis. This material was examined by one of us (H. C. B.) while working in the Pathological Institute during the year 1920.

bradycardia, shortly after he became markedly drowsy and developed left central seventh and twelfth nerve paralysis. He lapsed into coma and died on October 11, 1931. Necropsy was performed by Dr. J. E. Smadel. The right lung in this case (Fig. *1*) showed definite bronchiectasis and at the extreme base gangrene of the lung. This bronchiectasis was undoubtedly the result of his previous attack of influenza and his empyema was in turn due to the bronchiectatic condition. The large abscess present in the left frontal area of the brain is indicated in Fig. *2*. There was a similar, though not quite so large an abscess in the right pre-Rolandic area. The histologic studies recorded in this case by Dr. McCordock have been referred to in the text. In Fig. *3*, one sees a cross-section taken through the brain at the level of the abscess. *A*, indicates the wall of the abscess cavity. Between it and normal brain tissue (*C*), one sees many dark staining areas (*B*). These represent collections of loosely coiled spirochetes, (*4* and *5*).

Bibliography*

Chapter I

Etiology and Pathology

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Phrenicectomy as a Prophylactic Measure Against Bronchiectasis

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The Fate of the Individual With Untreated or Inadequately Treated Bronchiectasis

Ballon, H. C.: Unpublished data. *Findlay, L., and Graham, Stanley:* Arch. Dis. Childhood **6**: 1, 1931. *McCordock, H.:* Proc. Soc. Exper. Biol. and Med., to be published June, 1932.

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NEW PORTABLE PNEUMOTHORAX MACHINE*

J. J. Singer, M.D.
St. Louis, Mo.

THIS machine is presented because it embodies many desirable features which will be enumerated.

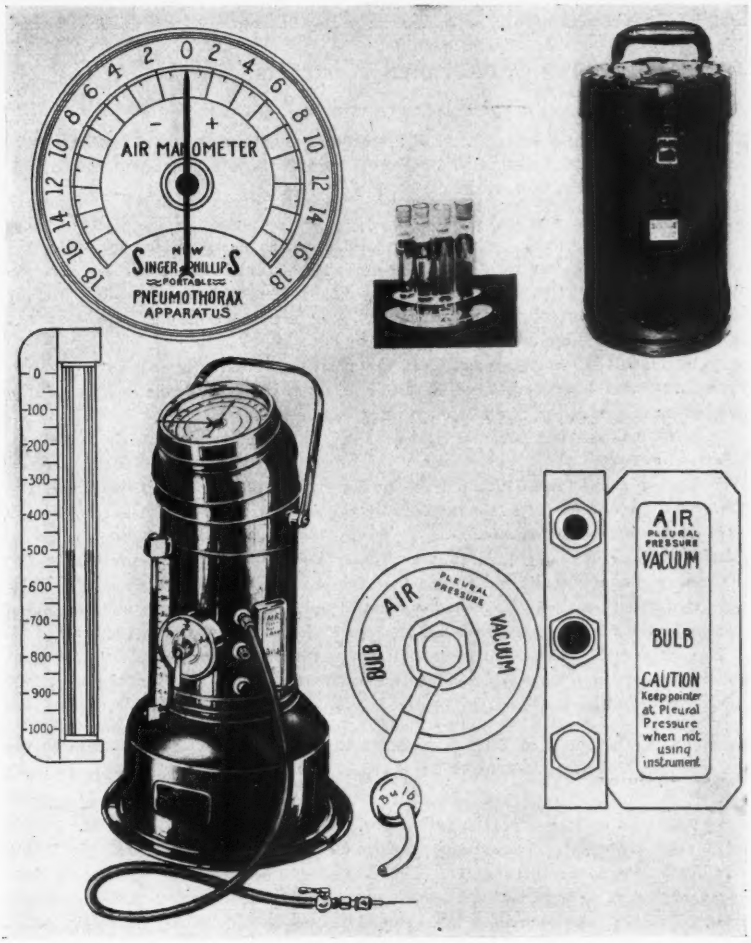
It is made almost entirely of metal sufficiently heavy to withstand accidental tipping or breakage. The transparencies are made of heavy break-resisting glass and the gauge is made of hard glass. The apparatus consists essentially of two chambers, an upper and a lower. The new type manometer consists of a bellows, enclosed in a metal case, which opens and closes with the variations of the air pressures within. The needle on the dial shows these variations of pressures in cubic centimeters of water. It is mounted on fine jeweled bearings. Air can be put into or withdrawn from the chest through the commutator valve in the center of the instrument. Pleural pressure readings may also be obtained by changing the handle of this valve. We use 1000 c.c. of mineral oil instead of water as this does not corrode any of the metal parts. Tubing to which is attached a needle with a valve is inserted into the uppermost opening, and with the commutator valve placed in the proper position it is ready for use in pneumothorax work or aspirating air from the chest. A small test tube rack may be attached to a clip on the back of the machine which is not visible in the photograph. The apparatus as illustrated weighs ten pounds.

MODUS OPERANDI

The commutator valve is placed pointing to "Bulb." Air is pumped through the middle opening on the side which forces the mineral oil which is in the lower chamber into the upper chamber. By watching the gauge at the side of the machine one can readily see the amount of fluid in the upper chamber which indicates a similar amount of air in the lower chamber. Turning the commutator valve now to "Pleural Pressure" with the tube in the upper opening we are ready to insert the needle after proper preparation into the patient's chest. Negative pleural readings are recorded contraclockwise and positive readings on the plus side of the scale. If suitable pleural readings are obtained one now moves the indicator to the point marked "Air." This permits the fluid to drop from the upper to the lower chamber and forces the air out through the tube and into the chest cavity. Here again the amount of fluid which escapes into the lower chamber indicates the amount of air injected. By merely turning the handle to "Pleural Pressure" one can see the record of the changes in pleural pressures. If the pleural pressure is positive or too high, by turning the commutator handle to

*From the Department of Medicine of Washington University and the Medical and Surgical Chest Service, Barnes Hospital, St. Louis, Mo.

"Vacuum" the air is withdrawn from the chest and the amount is indicated by the drop in fluid in the gauge. When the desired pleural pressures are obtained the needle is withdrawn from the chest and the operation is completed.



Portable pneumothorax machine. Inserts show detail drawings of the most important parts of the apparatus. (See text.)

The important advantages of this machine are: (1) Its simplicity of operation. (2) Its sturdiness. (3) Visibility of all the indicators so that all possible changes in the pleural cavity, and also in the machine itself, are instantly recorded. (4) Its portability without danger of breakage or leakage.

Made by Wm. A. Phillips, 922 Pine Street, St. Louis, Missouri.

Department of Reviews and Abstracts

CONDUCTED BY DUFF S. ALLEN, M.D., ASSOCIATE EDITOR

Selected Abstracts

Hamilton, W. F., and Morgan, A. B.: Mechanism of the Postural Reduction in Vital Capacity in Relation to Orthopnea and Storage of Blood in the Lungs. Am. J. Physiol. **99**: 526, 1932.

By experiment it was found that:

1. In five normal subjects, while the vital capacity decreased on assuming the recumbent position, the residual air remained constant. (Residual air was determined from $O_2 + CO_2$ after ventilating the lungs with O_2, exhaling to the residual air and rebreathing a known quantity of nitrogen to a complete mixture.)

2. The size of the chest did not decrease but rather tended to increase in the recumbent position when measured at the position of extreme inspiration or expiration. Chest diameters were determined by calipers and the height of the diaphragm and width of the chest by x-ray examination.

3. In four normal subjects the vital capacity in the recumbent position promptly increased about to the equal of the vital capacity in the upright position when blood pressure cuffs were applied to the bases of the four extremities and the blood was trapped in the arms and legs by raising the pressure in the cuffs to the level of the diastolic pressure.

It was therefore concluded that a greater volume of blood is present in the chest when the subject is recumbent than when upright. This accounts for a decrease in vital capacity in the recumbent position. The mechanism of blood storage in the lungs is discussed and its relation to orthopnea is pointed out.

The authors also found that in certain cases of cardiac disease the vital capacity was increased by the application of the cuffs. Details of this finding were not given in the article. *(Byron F. Francis)*

Ernstene, A. Carlton, and Blumgart, Herrman L.: Orthopnea: Its Relation to the Increased Venous Pressure of Myocardial Failure. Arch. Int. Med. **45**: 593, 1930.

The authors believe that the orthopneic position decreases the distress of the patient with congestive circulatory failure because it secures a maximum blood flow about the respiratory center. This is brought about chiefly by the diminution in cerebral venous pressure which accompanies an elevated position of the head. This, in turn, increases the arterial venous gradient in the capillaries of the respiratory center. Consequently the flow is allowed to increase thereby favoring decreased anoxemia in the respiratory center itself. Accordingly, a patient with myocardial failure and increased venous pressure tends to keep his respiratory center elevated above the top of the column of venous blood extending upward from the right atrium.

In order to test the validity of this hypothesis several experiments were carried out.

1. Eighty-two measurements of the venous pressure and the perpendicular distance between the occipital protuberance and the level of the right atrium were

made in twenty-two patients with myocardial failure. A parallelism between the height of venous pressure and the degree of orthopnea was observed. In general, the higher the venous pressure, the greater the orthopnea.

2. Elevation of the head by flexion of it on the thorax when the patient was flat in bed produced in all but one instance, a conspicuous, although usually not complete, diminution of respiratory distress.

3. The direction of change in vital capacity with flexion of the head was not constant. In one fourth of the observations there was no change, in the others it varied from a maximum diminution of 200 c.c. to a maximum increase of 250 c.c.

4. Sixty-three comparisons of the vital capacity in the orthopneic and flat positions in eighteen subjects showed an average of only 8.3 per cent reduction in the recumbent position. In seven observations there was no change and in twenty-two observations the change was less than 5 per cent. *(B. F. Francis)*

Nissen, R.: Weichteilplastik zum Verschluss besonderer Formen von Empyemresthöhlen. (A Soft-Part Plastic Operation for the Closure of Some Forms of Chronic Empyema Cavities.) Zentralbl. f. Chir. **58**: 2130, 1931.

Chronic empyema cavities situated in the posterior mediastinal recess may remain unobliterated even after thoracoplasty. The difficulty of closure of cavities in this location by any form of bone plastic operation is pointed out. Nissen describes a soft-tissue bridge-pedicled flap technic for their filling and effacement. The flap consists of a large bridge of skin, subcutaneous fat and a long muscle strip lifted up and swung from the erector spinae. The procedure is performed in two or three stages the details of which are given in several illustrations. Two patients with chronic empyema cavities bearing bronchial fistulae lying in the posterior mediastinal recess were thus operatively treated with excellent results. *(Maurice M. Berck)*

Kerley, P.: Congenital Diseases of the Lungs. Brit. J. Radiol. **5**: 51, 1932.

Congenital lesions are much commoner in the lungs than in the heart. There is a definite and persistent tendency in man for the formation of a fourth lobe in the right lung and a less marked tendency for the formation of a third lobe in the left lung. The fourth lobe in the right lung is present in all quadrupeds and is well developed in the higher apes. A well developed fourth lobe in the right lung is present in 15 per cent of normal individuals and a third lobe in the left lung in a slightly smaller percentage. In no less than 40 per cent of normal people evidence of accessory lobes can be found in a furrow running across the lower part of the lower lobes. The remnants of these lobes are a potent factor in the development of bronchiectasis. Like a lobe cut off by the azygos vein, a basal accessory lobe may have deficient aeration, but this depends on whether it has a separate bronchial supply direct from the main stem, or whether it is supplied by the small paracardiac branch of the lower lobe bronchus. If it has a direct supply from the main stem, the individual has a reasonable chance of reaching old age; if its supply is the paracardiac branch of the lower lobe bronchus, collapse and bronchiectasis are almost certain to result. The paracardiac branch of the lower lobe bronchus is a bronchus of the third degree and as such contains only irregular fragments of cartilage; these are insufficient to maintain the tube rigid if it has to support a lobe, hence the lobe promptly collapses. The only function of the cartilage in the bronchial system is to maintain the tubes rigid and open. Without cartilage the air pressure could not keep the large bronchi open, and any simple catarrhal infection, temporarily diminishing the muscular tone, would result in the walls flapping together like the walls of a piece of small gut. Normally the adjacent elastic lung tissue and large bronchi supply some of the

necessary support. Diminution of this support by the interposition of a fissure may be an additional reason for collapse. The x-ray appearances of a collapsed accessory lobe are characteristic. With increasing deflation the lobe slowly becomes more opaque, its outer border becomes denser and straighter, and eventually the whole lobe sinks into the paravertebral groove, where it appears through the heart shadow as a triangular opacity. Its final collapse is hastened by the marked compensatory emphysema of the neighboring lobe. In the majority of cases bronchiectatic dilatation takes place in the collapsed lobe, and infection follows sooner or later. The interval between dilatation and infection may be several years. Up to the present, many accessory lobes have been diagnosed as collapsed lower lobes, and the collapse has been attributed to bronchiectasis. The two causes for dilatation in accessory lobes are (1) the bronchiectasis that follows any prolonged collapse (as in foreign body or bronchial carcinoma) and (2) a congenital quantitative or qualitative loss of elastic tissue in these fourth lobes.

We must discard the theory that infection plays a dominating part in the causation of infantile bronchiectasis. Examination of 60 proved (bronchography) cases of bronchiectasis at the Royal Chest Hospital revealed that 50 per cent of them lacked the "typical" symptoms of bronchiectasis, i. e., toxemia, debility, cough and purulent expectoration. In most of the cases without "classical" symptoms of bronchiectasis the diagnosis was bronchitis, postpneumonic fibrosis or asthma.

Additional evidence of the congenital nature of these lesions can be found in the facts that (1) most of the radiographs of congenital heart disease (Rossler) show developmental abnormality of the bony thorax (2) radiographs of bronchiectasis in children show in 60 per cent of them congenital anomalies of the bony thorax.

Collapsotherapy for bronchiectasis may have temporarily good results, but the patient is not cured and the lesion in the paravertebral groove is still flourishing. If the idea of a congenital lobar origin of bronchiectasis is correct, there is only one rational method of treating bronchiectasis with lobar collapse, and that is removal of the lobe. *(M. M. B.)*

Sergent, Emile: Bronchiectasies abcédées-Abcés bronchiectasiants et abcès bronchiectasiques. (Bronchiectasis With Abscess Formation, Bronchiectasis Secondary to Abscess, and Bronchiectatic Abscess.) Presse méd. **15**: February, 1932.

In studying the intricate and confused nosography of bronchiectasis, abscess and pulmonary gangrene, the author believes that the lesions may be dissociated into three main types:

I. Bronchiectasis with secondary abscess formation. The abscess or gangrenous area follows or complicates a preexistent bronchiectasis, of recent or of long standing. It is necessary to distinguish between two clinical eventualities of bronchiectasis. In the first, the bronchiectatic process is recent and subacute, appearing in the course of an acute bronchopneumonia. In serial bronchographies the evolution of the bronchiectatic process can be followed. In certain cases a resistance to bronchial evacuation is present, the bronchi are dilated but have preserved their integrity throughout. However in other cases, the process is more intense and destructive, and ulceration of the bronchial wall ensues. Here the pus penetrates into the peribronchial tissues and engenders what constitutes a peribronchial abscess. These lesions are usually multiple.

The second eventuality is better known. The bronchiectatic process is smouldering and chronic and of long standing but seems to exacerbate and flare-up with acute pneumonic episodes. These bouts of acute complicating broncho-

pneumonia have frequently as sequels abscesses or areas of pulmonary gangrene. In short, when they do not completely subside, these complicating bronchopneumonic areas are the initial stages of what we know as pulmonary abscess and pulmonary gangrene.

II. Abscess with secondary contiguous bronchiectasis. The author, under the term "abcès bronchiectasiants," designates the type of bronchiectasis that develops contiguous to an abscess. From a general viewpoint this type of bronchiectasis belongs to the category of bronchiectasis secondary to contractile sclerosis. An acute lung abscess which goes on to the chronic stage is surrounded by a zone of chronic sclerotic bronchopneumonia. The architecture of the bronchi traversing this area is affected by the sclerotic retractile process, and the alterations of dislocation, distention and dilatation of the bronchi follow when an acute lung abscess has not completely spontaneously subsided. This conception of the presence and action of a sclerotic ulceronecrotic bronchopneumonia is the basis of the indication for surgical treatment when an acute lung abscess does not quickly subside spontaneously.

III. Bronchiectatic abscess. The American authors under this term designate a complex anatomo-clinical process in which the abscess and the bronchiectasis evolve simultaneously. Sergent thinks this category is too elastic and cannot always withstand precise and critical examination. In many of these cases it is very difficult to distinguish between abscess complicated by bronchiectasis or bronchiectasis complicated by abscess, particularly if one has not witnessed the initial phases of the disease. All types of associations and complications are very frequently observed, i. e., simultaneous acute and subacute stages of abscess and bronchiectasis, subacute bronchiectasis complicating chronic abscess, peribronchial abscess complicating acute and subacute bronchiectasis, discrete areas of abscess or gangrene occurring in immediate contact or at some distance from latent chronic bronchiectasis.

Very frequently, even when one has the opportunity to witness the onset of the illness, cases are observed in which the stages of the disease (whether abscess complicated by bronchiectasis or bronchiectasis succeeded by abscess) are obscure, in which the two types of lesions are inextricably interwoven in a complex anatomic and pathologic evolutive problem. This evokes the conception of a suppurative bronchopneumonia with simultaneous distention and injury of the bronchi, more or less limited to a lobe, and rendering it a purulent sponge. Within this limit of definition one may place bronchiectatic abscess as distinguished from bronchiectasis with secondary abscess formation and abscess with secondary contiguous bronchiectasis. *(Maurice M. Berck)*

Eiselsberg, A., and Gold, E.: Uber das paravertebrale intramediastinale Hämatom bei Wirbelbrüchen. (Paravertebral Intramediastinal Hematoma in Spinal Fractures.) Deutsche Ztschr. f. Chir. **233**: 329, 1931.

The clinical pictures and typical radiologic appearance of paravertebral intramediastinal hematomata consequent to severe vertebral fractures are detailed with a series of accompanying case reports and x-ray pictures. The differential diagnosis between paravertebral abscess and hematoma consequent to fracture of the spine is delineated and the necessity stressed for accurate diagnosis for appropriate therapy. *(M. M. B.)*

Jessup, Parke, M.: Mediastinal Emphysema. Arch. Surg. **23**: 760, 1931.

Air can reach the mediastinum only by certain pathways. In the order of their frequency they are: (1) The pulmonary interstitial tissue, extending along the peribronchial and perivascular connective tissue to the loose areolar tissue of the

mediastinum; (2) extension of a subcutaneous emphysema along the endothoracic fascia, or the deep fascia at the jugulum; (3) direct sucking of atmospheric air through wounds in the superior and inferior apertures of the thorax; (4) injury of the trachea and main bronchi whereby air is blown directly into the mediastinum; (5) openings in the mediastinal pleura; (6) extension of retroperitoneal emphysema through the crus of the diaphragm.

The author reports seven cases of mediastinal emphysema. Four followed pneumothorax. Two of these were caused by puncture of the lung by spicules of bone from fractured ribs. The air reached the mediastinum along the interstitial tissue of the lung. In one, pneumothorax followed an operation for lung abscess, and the other occurred spontaneously secondary to pulmonary tuberculosis. In each of these the air traveled along the endothoracic fascia and muscle planes. In the fifth patient the air entered the mediastinum from a ruptured right main bronchus. In the sixth, air entered the mediastinum through an aperture left in the mediastinal pleura when a tumor was removed from this region. In the last patient the diaphragm was accidentally incised in the midline during the course of splenectomy and air was sucked into the mediastinum.

All seven of the patients died, autopsy was obtained in six.

The x-ray findings, while not considered characteristic in this condition, are at least helpful. In the five cases in which plates were obtained the medial borders of the lungs were found to be widely separated from each other, and there were longitudinal dark streaks and mottling in the mediastinal shadow. These were thought to be due to the accumulation of air in the tissues along the great vessels and between the parietal pleura and the bodies of the vertebrae.

The effects of mediastinal emphysema are believed to be the result of increased mediastinal pressure. The large veins entering both sides of the heart are compressed, the circulation is interfered with and the alarming symptoms and signs characteristic of this condition are produced. Those most commonly present are extreme cyanosis and dyspnea, rapid pulse, congestion of the superficial veins of the neck and low blood pressure. Substernal discomfort and pain may also be present.

In his review of the literature the author found reports of numerous cases which also illustrated the different mechanisms by which mediastinal emphysema is produced. *(Byron F. Francis)*

Tamiya, C., and Tamura, M.: Rontgenologisch-Experimentelle Studien über den Oesophagus mit besonderer Rücksicht auf die Pathogenese der sog. "funktionellen idiopathischen Oesophagusdilation." (Roentgenological Experimental Studies of the Esophagus With Particular Reference to So-Called "Idiopathic Functional Dilatation of the Esophagus.") Ztsch. f. d. ges. exper. Med. **78**: 337, 1931.

The authors have roentgenologically studied the esophagus of the dog with respect to the analogies present to idiopathic megaloesophagus and cardiospasm of man when the vagus and vagosympathetic trunks are stimulated with varying intensities and frequencies of electric current. Esophagismus and cardiospasm, atony and idiopathic dilatation of the esophagus form a closely related group of functional disorders of the esophagus, all on the common basis of the heightened irritability and functional disturbance of the vagus. The alternation of hypertonus and hypotonus of the vagus in individuals of clinical vagotonic habitus brings about esophago- and cardiospasm and atony and dilatation as direct results. When intermittent cardiospasm is conspicuous and strongly in the foreground, a functional dilatation of the esophagus if present is of minor degree; whereas, if cardiospasm is totally absent, the dilatation is likely to be striking and

appreciable. Cardiospasm is essentially the consequence of a disturbance in passage. These disturbances in motility spring essentially from weakening and alteration of the opening reflexes as carried by the vagi. So-called functional dilatation of the esophagus may be due to two distinct causes: (1) an organic lesion of or affecting both vagi, (2) a functional disturbance of the vagus and of the vegetative nervous system in the sense of lowered threshold and intermittency of stimulation, weakness of effect and alteration of irritability. Esophageal dilatation and passage-disturbances of the cardia may arise from alterations of central or reflex vagal impulses even in the absence of cardiospasm. *(M. M. B.)*

Lichtenstein, H.: Die Klinik und Pathologie der Primären Pleuratumoren. (Clinical Course and Pathology of Primary Pleural Tumors.) Deutsche Ztschr. f. Chir. **233**: 29, 1931.

In striking contrast to the great and seemingly increasing incidence of pulmonary (bronchial) carcinoma is the rarity of pleural tumors. Benign tumors of the pleura seldom manifest themselves clinically. Malignant pleural tumors not infrequently masquerade as tuberculous pleuritis. Clinically, however, three groups may be delineated, (1) a group characterized by a widespread placque-like growth with the microscopic picture of an endothelioma, (2) a group of metastatic pleural tumors, arising most commonly by centrifugal extension of bronchial carcinoma, occasionally metastatic from a nonthoracic neoplasm, (3) a group with the malignant histologic picture of sarcoma yet biologically of benign nature. A case of this latter group is reported in which the clinical syndrome of pseudoparalytic myasthenia gravis was presented. In spite of the malignant histologic picture of sarcoma, a relatively benign clinical course was evident. *(M. M. B.)*

Stéphani, J.: Les conditions nécessaires a la formation du liquide dans le pneumothorax artificiel uni et bilateral. (The Conditions Necessary for the Formation of Fluid in Unilateral and Bilateral Artificial Pneumothorax.) Rev. de la tuberc. **13**: 154, 1932.

For the most part the pleurisies of pneumothorax are tuberculous. In the great majority of these cases a tuberculous lesion is situated immediately subjacent to the air pocket. Pleural effusions are particularly common in the pneumothorax instituted relatively late in the course of the disease. In those cases of early fresh lesions, situated in the juxtahilar or subapical areas, in which the pneumothorax has been instituted after only a few months of the disease, the pleural space has remained dry throughout the course of treatment. The author believes that the absence of effusion in these early cases is due to the absence of tuberculous lesions of the pleura or immediately subjacent to it. *(M. M. B.)*

Proust, H., and Maurer, L.: La resection des apophyses transverses au cours de la thoracoplastie et de l'apicolyse. (Resection of the Transverse Process in the Course of Thoracoplasty and Apicolysis.) Bull. et Mém. Soc. nat. de chir. **57**: 1292, 1931.

Juxtavertebral resection of the transverse processes of the vertebrae in the course of rib resection in thoracoplasty presents several advantages. The further mesial the resection is made the better effacement of cavities is secured by the thoracoplasty. This increment in obliteration of cavities is secured through greater diminution of the transverse diameter of the cavities. The principal indication for resection of the transverse processes in the course of thoracoplasty lies in the cases of juxtahilar and juxtamediastinal cavities—those cavities lying in the "l'angle mart." Resection of the transverse processes is of great importance in the performance of

apicolysis. Three types of cases in which resection of the transverse processes was employed are presented.

(1) A case in which a cavity only partially closed by apical thoracoplasty was obliterated by the secondary operation of resection of the transverse processes.

(2) Juxtahilar cavities obliterated by the operation of thoracoplasty plus extensive resection of the adjoining transverse processes.

(3) Apicolysis combined with partial apical thoracoplasty.

Contraindications to employment of this method are present in cases with severely infected pleural lesions or bronchopleural fistulae because of the risk of infection of the vertebrae. *(Maurice M. Berck)*

Felix, W., and Mindus, W.: Plombierung bei Kavernöser Lungentuberkulose. (Plombage in Cavernous Pulmonary Tuberculosis.) Deutsche Ztschr. f. Chir. 233: 1, 1931.

The authors report upon a series of more than 100 patients with cavernous pulmonary tuberculosis treated by extrapleural paraffin plombage in Sauerbruch's clinic. To arrive at a clear judgment of the worth of the procedure it is necessary to analyze the possible causes of failure of plombage.

The following accidents have been noted:

(1) Suppuration and Elimination of the Plombe. (a) In spite of aseptic technic the "plombage bed" may be infected by the diseased pulmonary parenchyma by the lymphatic route. This infection may be manifest in the first few postoperative days or may come to light months or even years later. (b) Noninfected "plombage bed" exudates requiring aspiration for evacuation are not uncommon.

(2) Mechanical Complications. (a) Migration of the plombe may take place, the plombe descending from the apex to the base particularly in those cases in which the limiting adhesions are weak. (b) Compression of the right auricle with concomitant menacing cardiac arrythmia. Sauerbruch has stressed this as an urgent indication for prompt removal of the plombe. (c) Insufficient obliteration of the cavities. This particularly ensues if the cavities are situated near the medial aspect and have sclerotic walls. (d) Compression of the "bronchus of drainage" of the cavity with resultant retention of secretion favoring local extension of the lesion and systemic toxic symptoms. (e) Perforation of the cavity of the plombe, which may be produced at the time of operation or may ensue early or late in the postoperative course by pressure necrosis. This accident demands urgent extirpation of the plombe.

(3) The Possibility of "Spreads" by Bronchial Embolism. This complication is perhaps less to be feared after plombage than after partial thoracoplasty because of the preservation of cough.

(4) The Toxic Phenomena After Operation. This is a relatively infrequent complication.

The principal indication for the operation of plombage is in the patient with a small upper lobe cavity, in whom the neighboring lung is relatively unaffected, in whom pneumothorax and phrenicectomy have been unsuccessful and in whom thoracoplasty seems too formidable or cannot promise a success. *(M. M. B.)*

The American Association for Thoracic Surgery

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The American Association for Thoracic Surgery

Fifteenth Annual Meeting

THE Fifteenth Annual Meeting of the American Association for Thoracic Surgery was held in Ann Arbor, Michigan, April 18, 19 and 20, 1932. The clinical demonstrations of Dr. John Alexander and the Staff of the University Hospitals were impressive and stimulating adjuncts to the papers read as the scientific program. Two full mornings were given over to these clinical demonstrations.

The scientific papers read provided comprehensive reviews of many phases of thoracic surgery. A great number of new facts also were brought forth in them. The surgical treatment of pulmonary tuberculosis was extensively dealt with. Studies were reported on abscess of the lung, carcinoma of the lung, tumor of the mediastinum, experimental fixation of the mediastinum, carcinoma of the esophagus, chronic empyema, subphrenic infections, actinomycosis of the thorax and on the autonomic nerve supply of the thoracic viscera. These articles will be published in subsequent issues of the Journal of Thoracic Surgery.

The following officers were elected for the year 1933:

Dr. George P. Muller, Philadelphia, President

Dr. George J. Heuer, New York City, Vice President

Dr. Duff S. Allen, St. Louis, Secretary

Dr. Edward D. Churchill, Boston, Treasurer

Dr. Evarts A. Graham, St. Louis, Editor

For Councilor for 1 year: Dr. Frederick T. Lord, Boston

For Councilor for 4 years: Dr. Edward S. Welles, Saranac Lake

The following active members were advanced to senior membership:

Dr. Emil G. Beck, Berkeley, California
Dr. Samuel J. Crowe, Baltimore, Md.
Dr. James H. Kenyon, New York City
Dr. Willis S. Lemon, Rochester, Minn.
Dr. Allen O. Whipple, New York City

The following were elected to active membership:

Dr. David H. Ballon, Montreal
Dr. Harry C. Ballon, St. Louis
Dr. Earl H. Bruns (U. S. A.), Denver
Dr. Dean B. Cole, Richmond
Dr. William B. Faulkner, Jr., San Francisco
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Dr. Samuel Harvey, New Hartford, Conn.
Dr. Frank S. Johns, Richmond, Va.
Dr. Maurice McPhedran, Philadelphia
Dr. J. Arthur Myers, Minneapolis
Dr. Julian Moore, Asheville

The following were elected to associate membership:

Dr. Norman Bethune, Montreal
Dr. I. A. Bigger, Richmond
Dr. J. V. Bohrer, New York City
Dr. John N. Hays, Saranac Lake
Dr. Thos. J. Kinsella, Oak Terrace, Minn.

A telegram was read concerning Dr. Willy Meyer, the founder of this Association, whose obituary appears elsewhere in this issue of the Journal. "At request of Dr. Matas am sending following appreciation of Dr. Willy Meyer. My first invitation into the mysteries of thoracic surgery as a separate branch of general surgery took place in the year 1916 under the tutelage of Dr. Willy Meyer. This was one year before the founding of this Association in which Dr. Meyer was the leading spirit. It was in 1923 that we came to Chicago together to the annual meeting to read a paper at which time I was elected a member at his proposal. I now better realize the enormous worth and benefit he bestowed upon humanity when he called into being and officiated at the birth of the American Association for Thoracic Surgery. As one of his early pupils and later associate I can testify to the many heartaches and discouragements attendant upon early failures. But in time these were alleviated by his increasingly successful operative results as he overcame with increasing knowledge apparently insuperable difficulties. His indomitable energy, and enthusiasm were communicated to his coworkers and assistants so that by sheer force of precept and example the beginnings of this new surgery were carried on by his momentum. His faculty for communicating an irresistible fascination to this difficult work was one of his outstanding achievements. His willingness to help along and guide and impart his dearly won knowledge was characteristic of the man he was. We must not forget that the ease and confidence with which many present thoracic operations are planned and executed today are due in great part to the original impetus and the pioneering spirit of Dr. Willy Meyer." (Signed by Dr. Otto C. Pickhardt.)

The sixteenth annual meeting of the American Association for Thoracic Surgery will be held in Washington, D. C., May 9, 10, and 11, 1933.